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PHASE III SITE ASSESSMENT REPORT, FORMER SHELLER-GLOBE FACILITY 3200 MAIN STREET KEOKUK, IOWA

Prepared for
Sheller-Globe Corporation
Keokuk, Iowa
July 1991

Woodward-Clyde

Woodward-Clyde Consultants
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Overland Park, Kansas 66203

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July 17, 1991
WCC Project 91C7343

Mr. Jim Thayer
Iowa Department of Natural Resources
Solid Waste Section
Wallace State Office Building
Des Moines, Iowa 50319

Re: Former Sheller-Globe Facility
Keokuk, Iowa

Dear Mr. Thayer:

Enclosed for your review is the Phase III Site Assessment Report for the former Sheller-Globe facility located at 3200 Main Street, Keokuk, Iowa. Woodward-Clyde Consultants (WCC) is submitting the report on behalf of our client, Sheller-Globe Corporation. The report presents the results of the field investigation at the location of the former underground storage tanks conducted in May and June, 1991.

If you have any questions regarding the report, please direct them to Mr. Brian Yeich at United Technologies Corporation. He can be reached at (203) 728-7622.

Very truly yours,

David A. Dods
Project Engineer

Kathy L. Kissick-Davenport
Senior Project Scientist & Associate

drs

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1.0
INTRODUCTION

This report presents the results of the Phase III Site Assessment of the former underground storage tanks at the former Sheller-Globe facility located at 3200 Main Street in Keokuk, Iowa. This investigation was the third phase of field work conducted since the tanks were removed in October 1989.

Previous investigations were conducted to identify site conditions, the nature of contamination, and define the site hydrogeology. The previous investigations focussed primarily on the fill material in the vicinity of the tank excavation. The goals of this investigation were to:

- Evaluate groundwater flow directions and contamination in the native soils underlying the fill material where the tanks were located;
- Further evaluate the presence of remaining contamination in shallow fill material in the vicinity of the former tanks;
- Evaluate the presence of other sources of solvent contamination in the fill materials; and
- Evaluate the hydraulic characteristics of the native aquifer materials.

The field investigation was conducted by Woodward-Clyde Consultants (WCC) on behalf of Sheller-Globe Corporation during the period of May 20 through June 1, 1991. Field work was performed in accordance with the Phase III Site Assessment Work Plan dated February 22, 1991, prepared by Pollution Control Systems, Inc. Program modifications requested by the Iowa Department of Natural Resources (letter dated March 15, 1991) were also incorporated into the Phase III investigation.

The field investigation included the installation of four monitoring wells into the native tills, sampling of soils from borings used for those wells plus eight additional borings, sampling of groundwater from new and selected existing monitoring wells, and the

performance of slug and step-drawdown tests on wells in the native soils. This report describes the investigation activities conducted, presents the results of the investigation, and describes the current understanding of site conditions as they relate to the sources and extent of contamination. Based on that understanding, remediation options are then discussed.

2.0
BACKGROUND

Five underground storage tanks were removed from the southwest portion of the former Sheller-Globe facility in October 1989. The location of the former tanks and the general excavation area are depicted on Figure 1. The facility history, tank history, and field investigation results since that time have previously been reported to the Iowa Department of Natural Resources (IDNR) in the following documents:

- Sheller-Globe Corporation, Keokuk Plant, Site Assessment Work Plan, May 3, 1990, prepared by United Technologies Automotive.
- Site Assessment Investigation, Sheller-Globe, 3200 Main Street, Keokuk, Iowa, August 9, 1990, prepared for United Technologies Automotive by Pollution Control Systems, Inc.
- Phase II Site Assessment Subsurface Investigation, Sheller-Globe Facility, 3200 Main Street, Keokuk, Iowa, January 3, 1991, prepared for Sheller-Globe Corporation by Pollution Control Systems, Inc.

The reader is referred to those documents for details of the site history. Since the tanks were removed in 1989, previous field investigations have included the performance of a soil gas survey, field screening and sampling of shallow soil borings, installation of groundwater monitoring wells in the shallow fill material and in native soils, and the sampling of monitoring wells.

The primary emphasis of the previous investigations was to establish site physical characteristics and evaluate the extent of solvent contamination resulting from tank usage. The majority of the work focused on the shallow fill material. This Phase III investigation further characterized conditions in the native soils beneath the fill and evaluated the possible presence of sources of solvent contamination other than the former underground tanks.

3.0
INVESTIGATION ACTIVITIES AND METHODS

3.1 INTRODUCTION

All field work was performed in accordance with the Phase III Site Assessment Work Plan (Appendix A) dated February 22, 1991, prepared by Pollution Control Systems, Inc., and the Iowa Department of Natural Resources comment letter to Mr. Brian J. Yeich dated March 15, 1991 (Appendix B).

3.2 FILE REVIEW

In an attempt to further evaluate the possibility of contaminant sources in the study area other than the former underground storage tanks, the WCC field representative interviewed Mr. William E. Vandersall (Environmental Services Manager, Schlegel, Keokuk) on May 31, 1991. The results of the interview are incorporated into the discussion of results and conclusions in Section 5.0 of this report.

3.3 FIELD INVESTIGATION

The field work for the Phase III investigation was performed between May 20 and June 1, 1991. All drilling activities were performed by Hannibal Testing Laboratories of Hannibal, Missouri under the direction of the WCC field geologist. Soil samples and groundwater samples were analyzed by Enseco-Rocky Mountain Analytical Laboratories in Arvada, Colorado. In accordance with the Occupational Safety and Health Administration (OSHA) requirements of 29 CFR 1910, a site specific Health and Safety Plan was prepared by WCC and implemented during all phases of the field investigation.

3.3.1 Monitoring Well Installation

In order to further evaluate the horizontal extent of contamination in the native glacial till soils, the Phase III Work Plan called for the installation of three new groundwater

monitoring wells downgradient (estimated to the southwest) of the tank excavation. In addition to these wells, the comment letter from the IDNR dated March 15, 1991 called for the installation of an additional upgradient monitoring well. The upgradient well was proposed to evaluate the groundwater quality upgradient of the excavation and downgradient of the plant building and operations. The location of the new and existing monitoring wells are shown on Figures 1 and 2. The construction details for the monitoring wells are shown on Table 1 and the boring logs are presented in Appendix C.

Borings for monitoring wells MW-9, MW-11, and MW-12 were drilled with 4 1/4-inch I.D. (8-inch O.D.) hollow stem augers to a depth of 35 feet below ground surface. Samples were collected with split spoon samplers at 5-foot intervals in each boring. The boring for monitoring well MW-10 was drilled with 6 1/4-inch I.D. (9-inch O.D.) hollow stem augers to a depth of 30 feet. Split spoon samples were collected at 5-foot intervals from 0- to 10-feet then at 2.5-foot intervals from 10 feet to the bottom of the boring.

Headspace analyses were performed on samples from each depth interval using the procedures described in Section 3.2.1 and Appendix C of the Phase III Work Plan. Headspace results are presented in Table 2. The sample with the highest headspace instrument response per boring was submitted to the laboratory and analyzed for volatile compounds. In the cases where no volatile compounds were detected in the headspace, the sample collected nearest the top of the saturated zone at the time of drilling was submitted for laboratory analysis. No soil samples from the upgradient boring for MW-12 were submitted for laboratory analysis since that well was installed as a background well and field screening did not identify any volatiles present in the soil. The samples were analyzed for volatile organic compounds (VOCs) by EPA Method 8240. Analytes included in that method were the Target Compound List plus methyl isobutyl ketone, n-hexane, and butanol. These three additional compounds were included in all volatiles analyses because they were potentially present at the site.

The four monitoring wells were installed in general accordance with the procedures outlined in Section 3.2 of the Phase III Work Plan. The locations of the new monitoring wells (MW-9, MW-10, MW-11, and MW-12) are shown on Figure 1. With the exception of MW-10, all wells were constructed of 2-inch diameter, Schedule 40, flush coupled

PVC pipe with 10-foot sections of 0.010-inch machine-slotted screen. MW-10 was constructed of 4-inch PVC so it would accept a submersible pump for a pump test or future use as an extraction well.

The four monitoring wells were developed by bailing each well dry at least five times. In addition, water quality parameters including temperature, pH, salinity, and conductivity were measured in the field during development. The water generated during development was stored in the large steel tank immediately south of the excavation near the chemical storage building.

3.3.2 Soil Sampling

In addition to the three soil samples collected in conjunction with the installation of monitoring wells MW-9, MW-10, and MW-11, soil samples were collected from eight shallow soil borings. The purpose of the soil borings was to further identify any residual contamination in the shallow soils near the excavation and near the former product lines and to better define the source areas for soil and groundwater contamination. The Phase III Work Plan called for the collection of nine soil samples. However, one of the proposed sample locations southwest of the excavation and on the southeast corner of the chemical storage building was inaccessible to drilling equipment due to the presence of the large steel tank. Therefore, this location was deleted from the sampling program.

The location of the eight soil borings are shown on Figure 3. The borings were drilled in accordance with the procedures outlined in Section 3.2.1 of the Phase III Work Plan. Four of the borings (WCS-2, 3, 4, and 5) were drilled through asphalt and four (WCS-6, 7, 8, and 9) were drilled through concrete. Split spoon samples were obtained as near the surface as conditions would allow and at 4-6 and 8-10 feet below ground surface in each boring. The borings were advanced with 3 1/4-inch I.D. (6-inch O.D.) hollow stem augers. Headspace analyses were performed on samples from each boring in accordance with the procedures described in Section 3.2.1 and in Appendix C of the Phase III Work Plan. As with the samples collected from the monitoring well borings, the sample from each soil boring exhibiting the highest headspace instrument response was submitted to the laboratory and analyzed for volatile organic compounds (TCL List plus methyl isobutyl ketone, n-hexane, and butanol). Headspace results and the soil

samples submitted for analyses are summarized in Table 2. Boring logs are presented in Appendix C.

3.3.3 Groundwater Sampling

In accordance with Section 3.2.2. of the Phase III Work Plan, groundwater samples were collected from the four new monitoring wells and six existing wells (MW-1, MW-2, MW-3, MW-4, MW-6A, and MW-6B). Water levels were measured on May 30, 1991 and are summarized in Table 1. The ten wells were purged on May 30, 1991. Each well was bailed dry and allowed to recover overnight. Samples consisting of three 40ml glass vials for analysis of volatile organics were collected from each well with disposable polyethylene bailers on May 31, 1991. In addition, water quality parameters were measured in the field and included pH, temperature, conductivity, and salinity. The results of these measurements are presented in the sample collection field sheets (Appendix E).

In accordance with the Phase III Work Plan, quality assurance samples including a trip blank (TB-1) and a blind duplicate sample from MW-9 (labeled MW-14) were collected and submitted to the laboratory.

All groundwater samples were analyzed by Enseco-Rocky Mountain Analytical Laboratories for volatile organic compounds (Method 8240; target compound list plus methyl isobutyl ketone, n-hexane, and butanol).

3.3.4 Hydraulic Testing

3.3.4.1 Slug Tests

Slug tests were performed on monitoring wells MW-9 and MW-10 on May 31, 1991. Both rising and falling head tests were performed on MW-9. A falling head slug test was not performed on MW-10 because the water level in the well at the time the test was performed was only 0.54 feet below the top of the PVC casing. The insertion of the slug for the falling head test would have caused the water level to rise above the top of the casing and subsequently to spill over onto the ground surface. For this reason,

the slug was inserted into the well and the water level was allowed to re-equilibrate prior to beginning the rising head slug test at MW-10. All water level measurements were recorded using a Hermit 1000B Data Logger with a 10 psi transducer.

A solid PVC cylinder 8.03 feet long and 1.25 inches in diameter was used in the slug test on monitoring well MW-9 to produce a theoretical initial displacement of 3.12 feet in the 2-inch diameter well. A solid PVC cylinder 5 feet long and 3 inches in diameter was used in the slug test on monitoring well MW-10 to produce a theoretical initial displacement of 2.8 feet in the 4-inch diameter well. The falling head test on MW-9 lasted approximately 2 hours while the rising head test lasted approximately 1.6 hours. The rising head test at MW-10 lasted approximately 3.6 hours. The lengthy nature of the tests is reflective of the generally low hydraulic conductivities at the site and the amount of time necessary to obtain 90 percent recovery.

3.3.4.2 Pumping Test

A small scale qualitative pumping test was performed on monitoring well MW-10 on June 1, 1991. The purpose of this test was to determine the feasibility of using a "pump and treat" recovery system as a remedial alternative at the site.

Prior to beginning the test, an electric submersible pump with a 1 1/4-inch PVC discharge pipe was placed at the bottom of the 4 inch diameter PVC well. The well was pumped at a rate of 0.5 gallons per minute (gpm) and drawdown was measured at regular intervals with an electric water level indicator. The results of the water level measurements are shown in Table 5. The well was pumped dry after 69 minutes of pumping at 0.5 gpm. The approximately 34 gallons of water generated during the test was stored in the red steel tank immediately south of the excavation. Based on the water level measured in the well prior to the test, the well volume including filter pack was approximately 29.5 gallons. It is likely that the 34 gallons removed represent the dewatering of the well and filter pack and approximately 4.5 gallons of recharge from the formation.

3.3.5 Well Survey

In accordance with the IDNR response letter dated March 15, 1991, a well survey was performed to determine whether any water wells were present within a one-half mile radius of the former Sheller-Globe site. The well survey included a search of the Iowa Department of Natural Resources - Geological Survey Bureau (GSB) and United States Geological Survey (USGS) cooperative geologic file, a search of the Iowa Geologic Survey (IGS) "GEOSAM" tracking system, and a review of the City of Keokuk Water Department's distribution list.

The "GEOSAM" tracking system consists of records of borings or water wells submitted to the Iowa Geologic Survey by water well drillers. The records submitted by the drillers are often accompanied with rock core or chip samples from the boring. Once the records and samples are logged into the GEOSAM tracking system, they are available for inspection by the IGS geologist. The geologist inspects and classifies the samples and creates a stratigraphic log of the boring. The stratigraphic log contains information such as surface elevation, total depth, rock lithology, and sample condition. The information obtained by the geologist is entered into the GSB and USGS cooperative geologic file. Due to the fact that not all records in the GEOSAM database are accompanied by rock samples and that not all rock samples have been reviewed by the IGS geologist, the GEOSAM tracking system contains considerably more records than the GSB and USGS cooperative file. Both databases, however, are available to the public. It is important to note that these data bases record boring information and do not necessarily indicate that wells were completed in the borings.

In addition to searches of the two databases described above, a request was made to the City of Keokuk, Iowa Water Department to obtain the water distribution list for areas immediately adjacent to, and approximately three-quarters of a mile downgradient of the former Sheller-Globe site. Using the list obtained from the City, a visual survey was performed to identify residences which were not on the distribution list. Residences not on the distribution list could possibly be served by a private water well. The finding of the well survey can be found in Section 4.6.

4.0
RESULTS

4.1 SITE GEOLOGY

The geology beneath the south-central portion of the site in the vicinity of the tank excavation is generally characterized by a surficial layer of structural fill material overlying glacial till soils. Figure 4 shows a generalized cross-section of the site geology. The composition of the structural fill material varies somewhat from location to location across the site, but generally consists of firm to stiff, olive-brown medium plastic silty clay with sand, gravel, brick and wood fragments. The thickness of the fill material generally increases from east to west and ranges from approximately 5.5 feet at upgradient monitoring well MW-12 to approximately 12 feet near the tank excavation and chemical storage building. The fill material is somewhat thinner beneath the toe of the slope with approximately 8 feet at MW-10 and 2 feet at MW-11 in the employee parking lot.

The glacial till soil beneath the site generally consists of firm to very stiff, yellowish brown, medium to highly plastic clay with traces of fine to medium sand and fine gravel, and some gray mottling. Approximately 2 feet of dense, yellowish brown fine grained sand with traces of silt and gravel was encountered at 34 feet below the ground surface at monitoring well MW-11. Typically, in a glacial till setting the thickness and continuity of these sand and gravel zones may vary markedly from location to location and their occurrence is unpredictable. It is noted that more sand lenses were observed in the boring for MW-10 than were observed for the other three borings for the monitoring wells. (Boring logs are shown in Appendix C.) MW-10 was sampled at 2.5-foot intervals from 10 to 30 feet BGS while the other three borings were sampled at 5-foot intervals. The frequency of the sand lenses shown in the boring logs may simply be a function of the sampling interval. In other words, it is often difficult to evaluate subsurface conditions based on auger cuttings and sand lenses may or may not occur between the 5-foot sampling interval in the three borings. To date, none of the monitoring wells installed on-site have reached bedrock and therefore, the depth to bedrock or the thickness of the glacial till is not known at this time.

4.2 SITE HYDROGEOLOGY

The current on-site groundwater monitoring well network consists of five shallow monitoring wells screened in the structural fill material and eight wells screened in the upper portion of the glacial till. Water levels in the on-site monitoring wells were measured on May 30, 1991 and are summarized in Table 1. Water levels from the eight monitoring wells screened in the upper portion of the glacial till were used to construct the water level contour map presented in Figure 5. The map shows that at shallow levels in the glacial till, groundwater flow is to the southwest. The flow direction is generally consistent with the direction identified in previous investigations. Based on the water level contour map and on the water level measurements in the five shallow wells screened in the fill material, it is likely that a zone of perched groundwater exists in the fill material in the vicinity of the tank excavation. MW-1, MW-2, MW-3, and MW-4 displayed water levels ranging from 2.7 to 5.5 feet higher than those in the shallow levels of the glacial till. It is probable that the open tank excavation acts as a collection point for rain water and surface runoff and is a source of recharge to the fill material. This excavation is in the process of being closed.

As previously mentioned, approximately 2 feet of dense, fine grained sand with trace silt and gravel was encountered at 34 feet below the ground surface in the boring for MW-11. The water level in MW-11 was approximately 5 feet below the ground surface. In order to evaluate whether confined conditions existed and the 5-foot water level represented the head in a confined 2-foot sand lense, an additional boring was drilled approximately 2.75 feet south of MW-11. The boring was drilled with 3 1/4-inch I.D. hollow stem augers on May 24, 1991 to a depth of 18 feet below ground surface. The boring was allowed to remain open until May 28, 1991 when the water level was measured in the boring and in MW-11. The groundwater elevation in the boring was 622.40 feet above MSL and 622.64 feet above MSL in MW-11. These water level measurements suggest an upward vertical hydraulic gradient of approximately 0.01 feet/feet in the vicinity of MW-11. Because the boring was only drilled to 18 feet below ground surface and did not encounter the 2-foot sand lense encountered in MW-11 and because the two water levels were very close (±0.2 feet), it is likely that unconfined conditions exist. The consistency in the two water level measurements

suggest that the sand lenses are hydraulically connected to the overlying glacial till clays and that the water levels are representative of the true unconfined conditions at the site.

4.2.1 Hydraulic Testing

4.2.1.1 Slug Tests

Hydraulic conductivity values were hand-calculated using the method of Bower and Rice, 1976 (Reference 1), and Bouwer, 1989 (Reference 2), which were developed for unconfined aquifers. The results of the slug test hydraulic conductivity calculations are summarized in Table 3.

In order to assess the accuracy and reliability of the slug test results, hydraulic conductivities were calculated using Woodward-Clyde Consultants' SLUGT software (Version 7, February 1988). The calculations are based on the borehole diameter using the method of Bouwer and Rice (1976). A comparison of results is presented in Table 4. The hand-calculated values and SLUGT-computed values show reasonably good agreement.

The hydraulic conductivity value for the falling head test at MW-9 was 1.87×10^{-5} cm/sec and 5.58×10^{-5} cm/sec for the rising head test. The hydraulic conductivity for the rising head test performed at MW-10 was 4.38×10^{-4} cm/sec. The hydraulic conductivity values are generally consistent with those presented in the Phase II Site Assessment Subsurface Investigation Report dated January 3, 1991. Typically, the intergranular hydraulic conductivities of the clayey materials in tills are several orders of magnitude less than the conductivities of the sandy layers or fractures. As a result, the majority of the flow occurs in the sand layers or fractures. As previously mentioned, the extent and occurrence of the sand and gravel zones is often unpredictable, and the hydraulic conductivity values, therefore, may vary between wells depending on the soil conditions at a particular location.

4.2.1.2 Pumping Test

In order to help assess the feasibility of a groundwater recovery system as a possible remedial alternative, a simple pumping test was performed in monitoring well MW-10. The specific procedures followed in the pumping test are described in Section 3.3.4.2. The pumping test data are presented in Table 5 and Figure 6. The 4-inch PVC well was pumped dry in approximately 69 minutes at a pumping rate of 0.5 gallons per minute. A total of 34 gallons were pumped from the monitoring well during the pumping test, and this volume probably represents the dewatering of the 4-inch PVC casing and filter pack and approximately 4.5 gallons of recharge to the well. Based on these results and on results of the slug tests, it is not likely that groundwater recovery wells would be an effective remedial alternative at the site.

4.3 GROUNDWATER MOVEMENT

Based on the geometric mean of the hydraulic conductivity values obtained in the slug tests, the hydraulic gradient measured at the site, and on an average range of effective porosity values for clay soils, a range of groundwater velocities for the site was calculated. The calculation was based on the equation $V = (-k)(dh/dl)n_e$ where V = true velocity, k = hydraulic conductivity and dh/dl = hydraulic gradient, and n_e = effective porosity.

Using an effective porosity for clay soil of 25 percent, the groundwater velocity was estimated to be approximately 24 feet per year. With a porosity value of 30 percent, the groundwater velocity is estimated at approximately 20 feet per year. The calculation, however, does not account for factors such as volatilization, soil structure, temperature, soil moisture, or adsorption, all of which may greatly influence the rate of contaminant migration. On this basis, it is likely that contamination has not migrated at a rate equal to the groundwater velocity.

Groundwater flow at shallow levels in the glacial till generally follows topography, and the water table slopes from topographic highs toward the streams and drainages. Based on this knowledge, groundwater at shallow levels in the glacial tills is probably directed toward the topographic low of the cooling pond west of the excavation. In addition,

reinforced concrete and corrugated metal pipes located south and west of the excavation (Figure 5) may influence groundwater flow.

4.4 SOIL SAMPLE RESULTS

As described in Sections 3.3.1 and 3.3.2, soil samples were collected from the four soil borings used for the monitoring well installations and from eight additional shallow soil borings. Head space analyses were performed on all samples from each of the 12 borings to determine "worst case" or highest volatile concentration within each boring. The results of the head space readings are summarized in Table 2. Headspace readings ranged from background levels to 325 parts per million (ppm). Volatile organics were detected in the head space of samples from each of the shallow soil borings with the exception of WCS-9. Headspace readings ranged from background to 80 ppm in the zone 15- to 17-feet below ground surface (bgs) and from background to 90 ppm in the zone 5- to 7-feet bgs. The highest headspace measurements in the monitoring well borings were found at MW-9 (15 to 17 feet bgs) and MW-10 (5 to 7 feet bgs). Headspace readings were background for all samples from MW-11 and MW-12.

Soil samples displaying the highest headspace readings in each boring were submitted for laboratory volatile organic analysis (EPA Method 8240). The laboratory results are summarized in Table 6. Soil sample results are also plotted on Figure 3. Based on the field screening techniques described above, it is likely that the concentrations detected by the laboratory represent the highest concentrations of volatile organics within each boring.

The predominant volatile compounds detected in the soil samples were toluene, acetone, and methylene chloride. These three compounds were detected most frequently and in the highest concentrations. Toluene and methylene chloride were reported in former tank contents registration records. Concentration ranges for the three compounds in the soil boring samples were as follows:

Compound	Concentration Range (ug/kg)
Toluene	non-detect (5) - 2,200,000
Acetone	19 - 98,000J
Methylene Chloride	1.9 - 24,000J

Note: J = Result is detected below the detection limit or is an estimated concentration.

Total solvent concentrations were highest in borings WCS-2, WCS-3, and WCS-5, those located nearest the tank excavation. Lowest concentrations were found in soil samples from MW-9 and MW-11, two of the samples furthest away from the excavation. Intermediate levels were identified along the product distribution pipe and in borings WCS-7, WCS-8, and WCS-9.

A number of compounds were identified in boring WCS-7 that were not identified in any of the other borings. These compounds included carbon disulfide, 1,1-dichloroethane, 1,1-dichloroethene, hexane, and benzene. However, these compounds are not necessarily unique to that sample. The presence of toluene, acetone, and methylene chloride at high concentrations in some of the other soil samples resulted in elevated detection limits for other compounds on the Method 8240 analyte list.

The compounds detected in soil samples collected in May 1991 are generally consistent with those detected in samples collected in November 1990. However, the concentrations detected in May 1991 were considerably higher than those detected in November 1990. It is noted that the samples collected in November 1990 were not collected in the immediate vicinity of the tank excavation or the former product line and it is expected that concentrations would decrease as one moves away from the source.

4.5 GROUNDWATER SAMPLE RESULTS

Groundwater samples were collected from the four newly installed wells and from MW-1, MW-2, MW-3, MW-4, MW-6A, and MW-6B. All samples were analyzed using EPA Method 8240 for volatile organic compounds. The results of the groundwater sampling are shown in Table 7 and summarized on Figure 7.

In general, the most predominant volatile organic compounds detected were toluene and methylene chloride. Concentrations were highest in the two monitoring wells screened in the fill material immediately adjacent to the tank excavation (MW-1 and MW-2) with values ranging from 15,000 to 470,000 μg/L for individual analytes. Concentrations were much lower ($\leq$1,100 μg/L) in the sample from MW-4 approximately 20 feet to the east of the excavation area. Concentrations were also much lower ($\leq$460 μg/L) in samples from MW-3 and MW-9 located approximately 100 feet west of the tank excavation. Samples from the MW-6 monitoring well cluster contained several compounds including acetone, ethylbenzene, xylene, 1,2-dichloroethene, and trichloroethene in addition to toluene and methylene chloride. The shallow well MW-6A (completed in the fill material) displayed concentrations much higher than those detected in MW-6B (completed in the native tills). As with MW-6A and MW-6B, monitoring well MW-10 contained a variety of compounds not detected in samples from the monitoring wells immediately adjacent to the tank excavation (MW-1 and MW-2). Based on the results of previous sampling events (July 1990), it is likely that these compounds are present in the shallow groundwater near the excavation but were not detected during this sampling event due to the elevated detection limits for these compounds. Only low concentrations ($\leq$7.4 μg/L) of a few volatile organic compounds, including methylene chloride, toluene, acetone, 1,2-dichloroethene, and trichloroethene, were detected in upgradient well MW-12 and monitoring well MW-11, approximately 125 feet south of the tank excavation in the employee parking lot.

Monitoring well MW-6A exhibits comparatively high levels of solvent contamination relative to other wells distant from the excavation. In addition, the chemistry of the compounds in that well differs somewhat from other wells. Specifically, the highest levels of ethylbenzene (19,000 ug/l) and xylene (56,000 ug/l) were found in MW-6A. These results suggest a source area other than the tank excavation. Facility personnel indicate that a former chemical storage and mixing building was once located in that general area (see Figure 2). Additionally, a number of water lines cross the area. The excavations for those lines may have acted as conduits for contaminant migration at one time.

Conversely, the soil sample results do not confirm the presence of a second source area. Borings WCS-7, WCS-8, and WCS-9 located around MW-6A do not show the elevated levels of xylene and ethylbenzene. As a result, the groundwater results from MW-6A suggest a second source area, but the evidence is not conclusive.

4.6 WELL SURVEY RESULTS

A well survey was performed to determine if any private water wells are located adjacent to or in the immediate downgradient vicinity of the site. The survey consisted of a search of two IGS databases and a review and field survey of the City of Keokuk's municipal water distribution list in the vicinity of the site.

A search of the IGS GEOSAM tracking system revealed the presence of five potential water wells in the vicinity of the site. Four of these wells were previously identified in the Site Assessment Investigation dated August 9, 1990, prepared by Pollution Control Systems. The exact location of the fifth potential well could not positively be identified with the GEOSAM database. The record only specifies that the potential well is within Section 23 of T65N, R5W. Only two possible wells were identified in the GSB and USGS cooperative geologic file database. Both wells were in Section 24 of T65N, R5W and approximately three-quarter of a mile to the east of the site. The production well identified on-site is not in use. The locations of the potential private water wells are shown on Table 8 and Figure 8. According to the information in the two databases, the seven borings or wells were drilled into the local bedrock aquifer and not in the shallow glacial till aquifer of concern at the site.

A municipal water distribution list for the site vicinity was requested from the City of Keokuk's Water Department. At the time the request was made, the water department employee indicated that all residences and businesses within the Keokuk city limit are served by municipal water system and that the city water is obtained from the Mississippi River.

Using the water distribution list obtained from the city water department, a survey was performed to identify any residences that were not on the city distribution list. The location of the distribution list survey is shown on Figure 8. All streets immediately

adjacent to and approximately 1 mile west of the former Sheller-Globe site were surveyed. Only one residence not on the city water distribution list was identified in the field survey. The residence is located at 1148 Johnson Street Road. It is not known at this time whether this residence is served by a private water well. All other residences were on the city distribution list.

Based on the results of the well survey, it does not appear likely that residential drinking water wells are present in the immediate (within 0.5 mile) downgradient vicinity of the tank excavation. It is noted, however, that the two database searches only reveal the potential locations of residential water wells. These records do not indicate whether the boring at a specific location was completed as a well or if a well has been abandoned since its completion. In addition, old wells may exist which are not on either of the computer databases.

5.0
CONCLUSIONS

The Phase III Site Assessment Field Investigation included the installation of four monitoring wells into the native soils, sampling of soils from borings used for those wells, plus eight additional borings, sampling of groundwater from new and selected existing monitoring wells, the performance of slug tests and a pumping test, and a well survey in the vicinity of the site. The key findings of the field investigation are as follows:

The former underground storage tanks appear to be the predominant source of soil and groundwater contamination. The highest contamination levels are in the fill material immediately adjacent to the former tank area. Lower contaminant concentrations are present along the former product line and in the vicinity of wells MW-6A and 6B. The former chemical storage building may be the source of contamination near those two wells.

The tanks were located in a zone of fill material. The fill material ranges in thickness from approximately 5.5 feet near well MW-12 to 12 feet near the tank excavation. This fill material overlies native glacial till soils composed of clays with traces of sand and fine gravel. Two water bearing zones were identified during the investigation, one in the fill material and one in the native tills. The water in the fill material is believed to be a perched water zone, recharged through the tank excavation and other openings and cracks in the parking lot that covers the fill material. The second water bearing unit is an unconfined water table that was encountered in the upper portion of the native tills.

The predominant contaminants are toluene, methylene chloride, and acetone in soils, and toluene and methylene chloride in the groundwater. Contamination levels are highest in the fill material immediately surrounding the excavation, and decrease markedly away from the excavation and in the native tills beneath the fill. For example, total solvent concentrations in groundwater ranged from 492,300 ug/l in well MW-1 next to the excavation, to 39,230 ug/l in MW-10 located in the till immediately downgradient

of the excavation, to 21.1 ug/l in well MW-11 located farther south in the employee parking lot. This contamination pattern is consistent with the site geology and history. Contamination levels are at least one order of magnitude higher in the fill material than the native tills immediately below it. They then decrease another 2 to 3 orders of magnitude in wells further away from the excavation. This would be expected considering the heterogeneous nature of the fill material compared to the clay materials in the native tills.

The exception to this pattern is well MW-6A where the groundwater sampling results suggest a possible second contamination source near this well location.

The soil sampling results follow a similar pattern as the groundwater results. Total solvent concentrations are highest immediately adjacent to the tank excavation then decrease away from that area.

Groundwater flow in the native tills was measured to be toward the southwest, and is expected to generally follow site topography. However, buried drainage pipes beneath the employee parking lot may also influence and/or intercept shallow groundwater in the till.

The slug and pump tests confirm that the wells in the native tills are slow to recharge. During the pump test, well MW-10 was pumped dry at a flow rate of one-half gallon per minute. This indicates that recovery wells would not be a viable option for collecting contaminated groundwater.

Finally, the well survey results did not identify any residential water wells in the immediate downgradient vicinity of the site.

6.0
RECOMMENDATIONS

With the completion of this investigation, data is available to begin evaluating remedial measures for contamination resulting from the former underground storage tanks. Two major conclusions from this investigation affect the choice of remedial measures. First, the highest levels of solvent contamination remain in the fill material in the vicinity of the former tanks excavation. Solvents in the fill material are believed to be a continuing source of contamination to shallow groundwater. Second, the upper portions of the native till sediments are sufficiently dense and fine grained that groundwater recovery wells are not a viable remedial measure.

Based on these conclusions, it is recommended that remediation of the fill material be initiated to control the ongoing source of solvent contamination to the groundwater. Remediation of the fill will require dewatering the perched water table and removing solvents from the fill soils. It is recommended that a high vacuum (hi-vac) vapor extraction system be evaluated as one of the potential remediation measures. The hi-vac system is capable of extracting both water and vapors from soil systems, and can be installed around building and high traffic areas without a lot of excavation required.

In order to evaluate a vapor extraction system, the following will need to be conducted/addressed:

- The performance of a pilot test;
- The identification of regulatory requirements for air and water discharges; and
- The establishment of cleanup goals and monitoring requirements.

These issues will be further discussed with the IDNR subsequent to submittal of this report to the agency.

Since the pump test conducted at well MW-10 caused the well to pump dry in 69 minutes at a flow rate of only 0.5 gallons/minute, the installation of groundwater recovery wells to remediate groundwater appears impractical. Monitoring of the native till wells is recommended to evaluate the effect of the proposed source remediation on groundwater quality. Additionally, the installation of the following new shallow till wells downgradient of MW-10 is proposed to further define the migration and attenuation of the contamination in the upper till:

- One well downgradient (southwest) of MW-10 located just east of the 36-inch drainage pipe running under the employee parking lot; and

- One well downgradient (southwest) of MW-10 located southwest of the 36-inch drainage pipe near the facility boundary.

The proposed well locations are shown on Figure 5.

7.0
REFERENCES

1. Bouwer, H., and Rice, R.C. (1976), A Slug Test for Determining Hydraulic Conductivity of Unconfined Aquifers with Completely or Partially Penetrating Wells, Water Resources Research, Vol. 12, No. 3.

2. Bouwer, H. (1989), The Bouwer and Rice Slug Test - An Update, Groundwater, Vol. 27, No. 3.

TABLES

TABLE 1

SUMMARY OF MONITORING WELL CONSTRUCTION DETAILS AND WATER LEVELS

Well I.D.	Date Installed	Elevation of Top of PVC Casing[1] (feet)	Elevation of Ground Surface (feet)	PVC Casing Diameter (inches)	Total Depth[2] (feet)	Screened Interval Elevation (feet)	Depth of Groundwater[3] (feet)	Groundwater Elevation
MW-1	October 1989	640.94	NA	4	14.21	625.94 - 635.94	4.94	636.00
MW-2	October 1989	640.34	NA	4	12.75	627.24 - 637.24	6.63	633.71
MW-3	October 1989	639.02	NA	4	16.77	622.32 - 632.32	11.29	627.73
MW-4	October 1989	640.94	NA	4	11.92	625.94 - 635.94	45.40	636.54
MW-5	November 1990	640.74	640.98	4	30.00	610.71 - 620.71	6.42	634.32
MW-6A	November 1990	641.13	641.43	2	13.94	627.26 - 637.26	5.58	635.55
MW-6B	November 1990	641.00	641.35	2	31.75	609.27 - 619.27	6.75	634.25
MW-7	November 1990	638.48	638.69	2	39.88	598.68 - 608.68	10.10	628.38
MW-8	November 1990	641.69	642.00	2	29.88	611.89 - 621.89	4.83	636.86
MW-9	May 1991	639.02	639.20	2	33.58	604.78 - 614.78	14.27	624.75
MW-10	May 1991	623.98	624.21	4	29.69	594.79 - 604.79	0.625	623.36
MW-11	May 1991	627.06	627.27	2	34.31	592.85 - 602.85	4.54	622.52
MW-12	May 1991	643.40	643.66	2	34.74	609.24 - 619.24	7.10	636.30

Notes:
1 All elevations are in feet above mean seal level.
2 Total depths measured from top of PVC casing on May 30, 1991.
3 Depth to groundwater measured from top of PVC casing on May 30, 1991.
NA = Data not available.

TABLE 2

SUMMARY OF HEADSPACE ANALYSES ON SOIL SAMPLES

Sample I.D.	Depth (feet)	Headspace Reading (ppm)[1]
WCS - 2	1.0 - 3.0	10
	4.0 - 6.0	75
	*8.0 - 10.0	100
WCS-3	*1.5 - 3.5	125
	4.0 - 6.0	58
WCS-4	2.0 - 4.0	20
	4.0 - 6.0	100
	*8.0 - 10.0	115
WCS-5	1.5 - 3.5	50
	4.0 - 6.0	100
	*8.0 - 10.0	130
WCS-6	4.0 - 6.0	90
	*8.0 - 10.0	100
WCS-7	*1.0 - 3.0	3
	4.0 - 6.0	1
	8.0 - 10.0	B.G.
WCS-8	4.5 - 6.5	25
	*8.0 - 10.0	325
WCS-9	0.5 - 2.5	B.G.
	4.0 - 6.0	B.G.
	*8.0 - 10.0	B.G.
MW-9	1.5 - 3.5	B.G.
	5.0 - 7.0	B.G.
	10.0 - 12.0	B.G.
	*15.0 - 17.0	80
	20.0 - 22.0	10
	25.0 - 27.0	15
	30.0 - 32.0	1
	35.0 - 37.0	4

TABLE 2
(Continued)
SUMMARY OF HEADSPACE ANALYSES ON SOIL SAMPLES

Sample I.D.	Depth (feet)	Headspace Reading (ppm)[1]
MW-10	1.0 - 3.0	4
	*5.0 - 7.0	90
	10.0 - 12.0	33
	12.5 - 14.5	18
	15.0 - 17.0	2
	17.5 - 19.5	2.5
	20.0 - 22.0	5
	22.5 - 24.5	1
	25.0 - 27.0	3
	27.5 - 29.5	6
	30.0 - 32.0	B.G.
MW-11	2.0 - 4.0	B.G.
	5.0 - 7.0	B.G.
	10.0 - 12.0	B.G.
	15.0 - 17.0	B.G.
	20.0 - 22.0	B.G.
	25.0 - 27.0	B.G.
	*30.0 - 32.0	B.G.
	35.0 - 37.0	B.G.
MW-12	5.0 - 7.0	B.G.
	10.0 - 12.0	B.G.
	15.0 - 17.0	B.G.
	20.0 - 22.0	B.G.
	25.0 - 27.0	B.G.
	30.0 - 32.0	B.G.
	35.0 - 37.0	B.G.

Notes: [1] All headspace measurements made with an HNu PI-101 photoionization detector in accordance with the procedures described in Appendix C of the Phase III Work Plan.

B.G. = Background.

* Sample submitted for laboratory analyses.

TABLE 3

SUMMARY OF SLUG TEST RESULTS

Well Designator	Slug Test Type	Hydraulic Conductivity (cm/sec)*	Screened Interval (feet bgs)
MW-9	Falling Head	1.87×10^{-5}	34.42 - 24.42
MW-9	Rising Head	5.58×10^{-5}	34.42 - 24.42
MW-10	Rising Head	4.38×10^{-5}	19.42 - 29.42

Notes: * Hydraulic conductivity values given are the hand-calculated results using the method of Bouwer and Rice, 1976.

TABLE 4

COMPARISON OF HYDRAULIC CONDUCTIVITY VALUES CALCULATED BY HAND AND SLUGT*

Well Designator	Slug Test Type	Hydraulic Conductivity (cm/sec) (Hand Calculated Results)	Hydraulic Conductivity (cm/sec) (SLUGT Results)
MW-9	Falling Head	1.87×10^{-5}	2.9×10^{-5}
MW-9	Rising Head	5.58×10^{-5}	1.32×10^{-4}
MW-10	Rising Head	4.38×10^{-5}	1.42×10^{-4}

Notes: * Calculations based on borehole diameter using the method of Bouwer and Rice (1976).

TABLE 5

SUMMARY OF PUMPING TEST DATA (MW-10)

Time	Elapsed Time (minutes)	Water Level (feet below T.O.C.)	Drawdown (feet)
06:22	0	1.69	0.00
06:27	5	4.81	3.12
06:29	7	6.08	4.39
06:30	8	7.15	5.46
06:33	11	8.02	6.33
06:35	13	9.27	7.58
06:36	14	9.88	8.19
06:40	18	11.48	9.79
06:41	19	12.15	10.46
06:43	21	13.00	11.31
06:44	22	13.79	12.10
06:46	24	14.88	13.19
06:48	26	15.71	14.02
06:51	29	16.63	14.94
06:53	31	17.79	16.10
06:55	33	18.35	16.66
06:57	35	19.17	17.48
06:58	36	19.54	17.85
06:59	37	19.88	18.19
07:00	38	20.31	18.62
07:01	39	20.54	18.85
07:03	41	20.94	19.25
07:05	43	21.21	19.52
07:06	44	21.40	19.71
07:10	48	22.35	20.66
07:11	49	22.71	21.02
07:12	50	22.94	21.25
07:15	53	23.81	22.12
07:17	55	24.42	22.73
07:18	56	24.69	23.00
07:19	57	25.00	23.31
07:20	58	25.29	23.60
07:22	60	25.88	24.19
07:23	61	26.10	24.41
07:24	62	26.38	24.69
07:26	64	27.04	25.35

TABLE 6

SUMMARY OF ANALYTICAL RESULTS ON SOIL SAMPLES
(Concentrations in ug/kg)

Compound	WCS-2 (8-10')	WCS-3 (1.5-3.5')	WCS-4 (8-10')	WCS-5 (8-10')	WCS-6 (8-10')	WCS-7 (1-3')	WCS-8 (8-10')	WCS-9 (8-10')	MW-9 (15-17')	MW-10 (5-7')	MW-11 (30-32')
Methylene Chloride	4600J	22000J	460J	24000J	520J	32	1100J	540J	1.9J	140J	2.5J
Toluene	320000	2200000	9500	1900000	27000	72	58000	13000	ND(5.0)	6200	ND(5.0)
Acetone	26000J	ND(200000)	2400	98000J	2400J	240	5300J	4000J	22	ND(1000)	19
2-Butanone (MEK)	ND(33000)	ND(200000)	ND(2000)	ND(200000)	ND(4000)	36	ND(6700)	ND(5000)	ND(10)	ND(1000)	3.3J
Carbon Disulfide	ND(16000)	ND(100000)	ND(1000)	ND(100000)	ND(2000)	2.0J	ND(3400)	ND(2500)	ND(5.0)	ND(500)	ND(5.0)
1,1-Dichloroethane	ND(16000)	ND(100000)	ND(1000)	ND(100000)	ND(2000)	12	ND(3400)	ND(2500)	ND(5.0)	ND(500)	ND(5.0)
1,1-Dichloroethene	ND(16000)	ND(100000)	ND(1000)	ND(100000)	ND(2000)	1.5J	ND(3400)	ND(2500)	ND(5.0)	ND(500)	ND(5.0)
Ethylbenzene	ND(16000)	ND(100000)	ND(1000)	ND(100000)	ND(2000)	15	ND(3400)	ND(2500)	ND(5.0)	1000	ND(5.0)
Xylenes (Total)	ND(16000)	ND(100000)	ND(1000)	ND(100000)	ND(2000)	190	ND(3400)	ND(2500)	ND(5.0)	2600	ND(5.0)
Hexane*	ND---	ND---	ND---	ND---	ND---	2.6J	ND---	ND---	ND---	ND---	ND---
Benzene	ND(16000)	ND(100000)	ND(1000)	ND(100000)	ND(2000)	4.5J	ND(3400)	ND(2500)	ND(5.0)	ND(500)	ND(5.0)

Notes: ND = Not detected (detection limit).
J = Result is detected below the reporting limit or is an estimated concentration.
* Detection limit is not shown because compound is not on the Method 8240 analytical list; compound was analyzed using a single point standard.
Compounds shown are ones which were detected during this sampling event. For a complete list of analytes, see Appendix G.

TABLE 7

SUMMARY OF ANALYTICAL RESULTS ON GROUNDWATER SAMPLES
(Concentrations in ug/L)

Compound	MW-1	MW-2	MW-3	MW-4	MW-6A	MW-6B	MW-9	MW-10	MW-11	MW-12
Carbon Disulfide	7300J	ND(25000)	ND(5.0)	ND(100)	ND(1600)	ND(25)	ND(25)	ND(1000)	ND(5.0)	ND(5.0)
Methylene Chloride	15000J	20000J	1.1J	81J	400	5.8J	ND(25)	23000	1.0J	1.4J
Toluene	470000	450000	39	1100	25000	680	460	9000	1.6J	5.7
Acetone	ND(50000)	ND(50000)	36	ND(200)	3600	ND(50)	ND(50)	ND(2000)	12	7.4J
Ethylbenzene	ND(25000)	ND(25000)	ND(5.0)	ND(100)	19000	170	ND(25)	370J	ND(5.0)	ND(5.0)
Xylenes (total)	ND(25000)	ND(25000)	ND(5.0)	ND(100)	56000	460	9.8J	1100	ND(5.0)	ND(5.0)
1,2-Dichloroethene (total)	ND(25000)	ND(25000)	ND(5.0)	ND(100)	ND(1600)	18J	ND(25)	290J	4.3J	1.8J
Trichloroethene	ND(25000)	ND(25000)	ND(5.0)	ND(100)	ND(1600)	11J	ND(25)	1900	2.2J	ND(5.0)
Chloromethane	ND(25000)	ND(50000)	ND(10)	ND(200)	ND(3300)	ND(50)	ND(50)	670J	ND(10)	ND(10)
1,1-Dichloroethene	ND(50000)	ND(25000)	ND(5.0)	ND(100)	ND(1600)	ND(25)	ND(25)	660J	ND(5.0)	ND(5.0)
Tetrachloroethene	ND(25000)	ND(25000)	ND(5.0)	ND(100)	ND(1600)	ND(25)	ND(25)	840J	ND(5.0)	ND(5.0)
1,1,1-Trichloroethane	ND(25000)	ND(25000)	ND(5.0)	ND(100)	ND(1600)	ND(25)	ND(25)	1400	ND(5.0)	ND(5.0)
Vinyl Chloride	ND(25000)	ND(25000)	ND(5.0)	ND(200)	ND(3300)	ND(50)	ND(50)	ND(2000)	ND(10)	3.1J

Notes: ND = Not detected (detection limit).
J = Result is detected below the reporting limit or is an estimated concentration.
Compounds listed are ones which were detected during this sampling event. For a complete list of analytes, see Appendix G.
All samples collected on May 31, 1991.

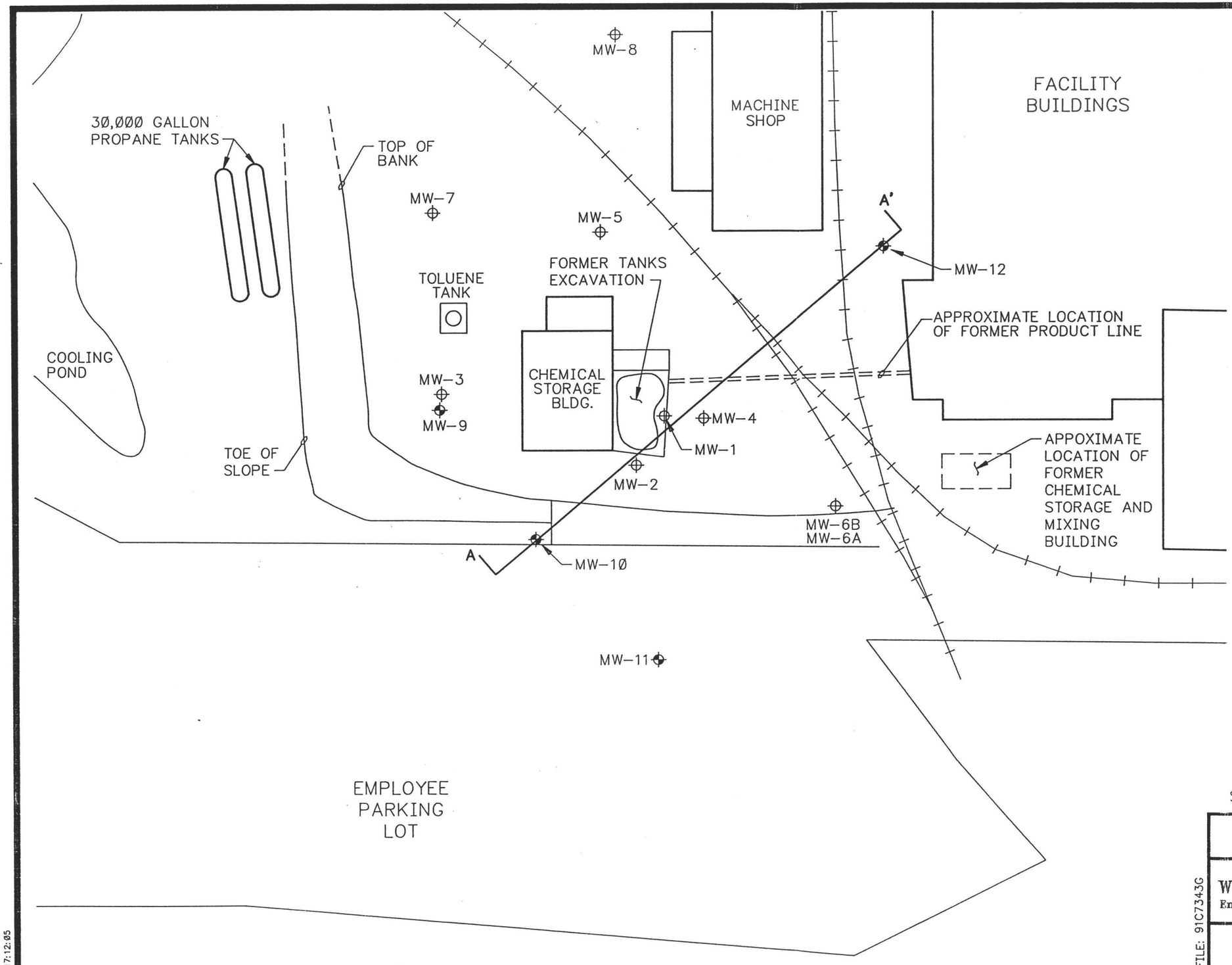
TABLE 8

SUMMARY OF POSSIBLE WATER SUPPLY WELLS IN VICINITY OF 3200 MAIN STREET, KEOKUK, IOWA

Boring[1] Number	Owner	Boring Number	Date of Completion	Static Water Level (feet)	Depth (feet)	Top of Casing Elevation	Location[1]
1	Ralph A. Wright	W-1245[2]	08-16-40	143	277	671	NW1/4, NW1/4, NE1/4, Sec. 23, T65N, R5W
2	Tri-State Dairy	W-15409[2]	06-14-61	142	271	660	T65N, R5W, Sec 23, NW NE, 2825 Main St.
3	Dryden Rubber Co.	W-0821[2]	08-17-38	NA	642	954	T65N, R5W, Sec. 23, SW NE, 32nd & Jackson St.
4	Harold Griffith	W-18028[2]	08-06-65	167	195	NA	T65N, R5W, Sec. 23, SW SW SE
5	Rose Wesley	W-992[2]	NA[4]	NA	280	NA	T65W, R5W, Sec. 23
6	NA	W-3171[3]	NA	NA	111	656	NE1/4, SE1/4, NE1/4, Sec. 24, T65N, R5W
7	NA	W-3576[3]	NA	NA	211	666	NE1/4, NE1/4, SW1/4, Sec. 24, T65N, R5W

Notes:
1 See Figure 8 for locations.
2 Information obtained from Geosam Tracking System in Iowa City, Iowa.
3 Information obtained from GSB and USGS Cooperative Geologic file.
4 NA = Not available.

FIGURES



LEGEND:

- RAILROAD TRACK
- MW-6A LOCATION OF EXISTING MONITORING WELLS
- MW-9 LOCATION OF NEW MONITORING WELLS INSTALLED IN MAY, 1991.
- A A' LOCATION OF GEOLOGIC CROSS-SECTION SHOWN IN FIGURE 3

N

50 0 50 100

SCALE FEET

FORMER SHELLER - GLOBE FACILITY
KEOKUK, IOWA

Woodward-Clyde Consultants
Engineers, Geologists, And Environmental Scientists

MONITORING WELL LOCATIONS
AND LOCATION OF
GEOLOGIC CROSS SECTION A-A'

DRAWN: M.A.L.	DATE: 07/01/91	PROJECT NUMBER	FIG. NO.
CHECKED: DS	DATE: 7/17/91	91C7343	2

ACAD FILE: 91C7343G

ACAD FILE: UTC-BS1
M.A.L.
ACAD R11 c2
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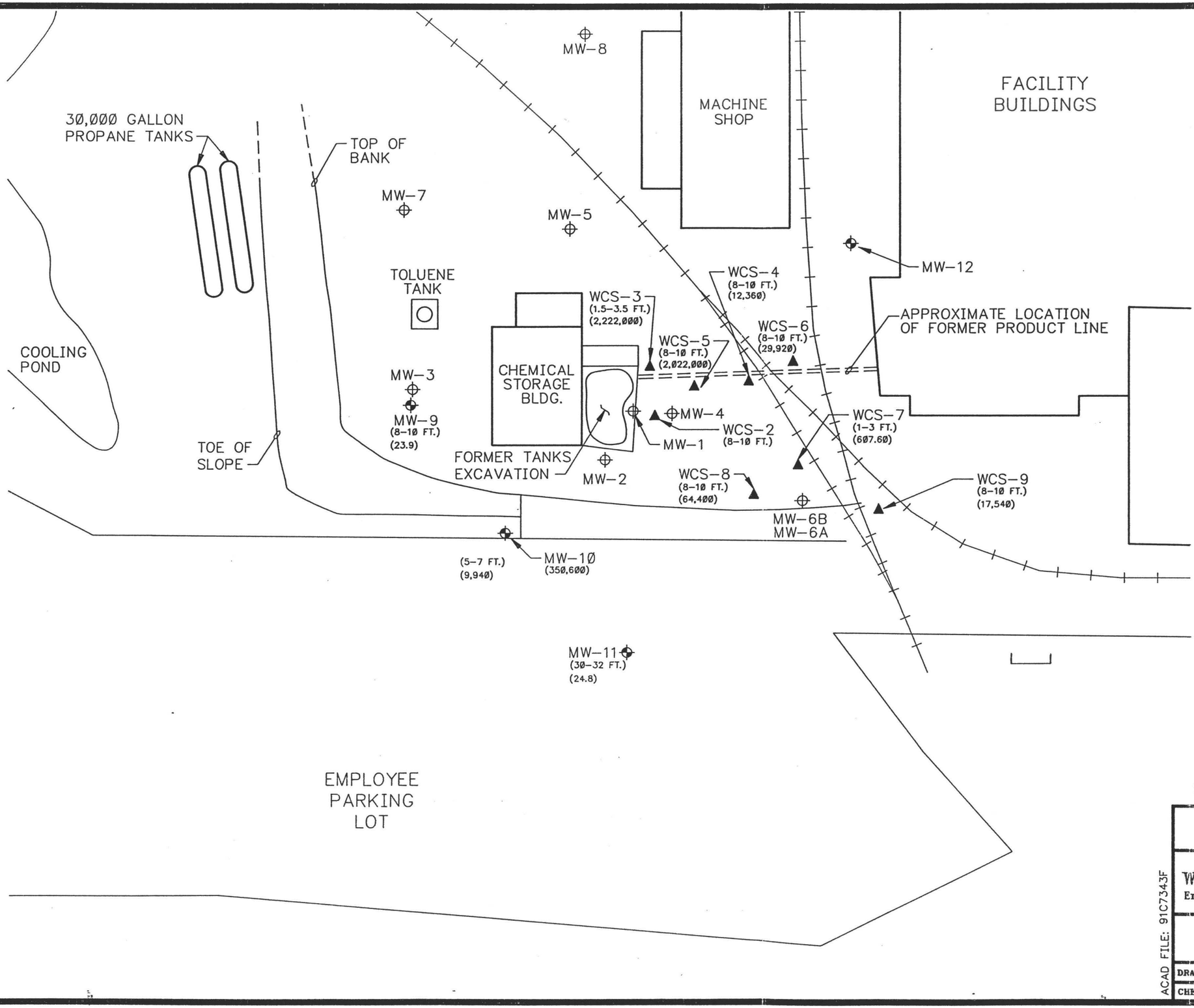
07/14/91 17:12:05



FORMER SHELLER - GLOBE FACILITY
KEOKUK, IOWA

Woodward-Clyde Consultants
Engineers, Geologists, And Environmental Scientists

SUMMARY OF VOLATILE ORGANIC COMPOUNDS IN SOIL; MAY 1991

DRAWN: D.D.S.	DATE: 06/24/91	PROJECT NUMBER	FIG. NO.
CHECKED: DE	DATE: 7/17/91	91C7343	3

ACAD FILE: 91C7343F

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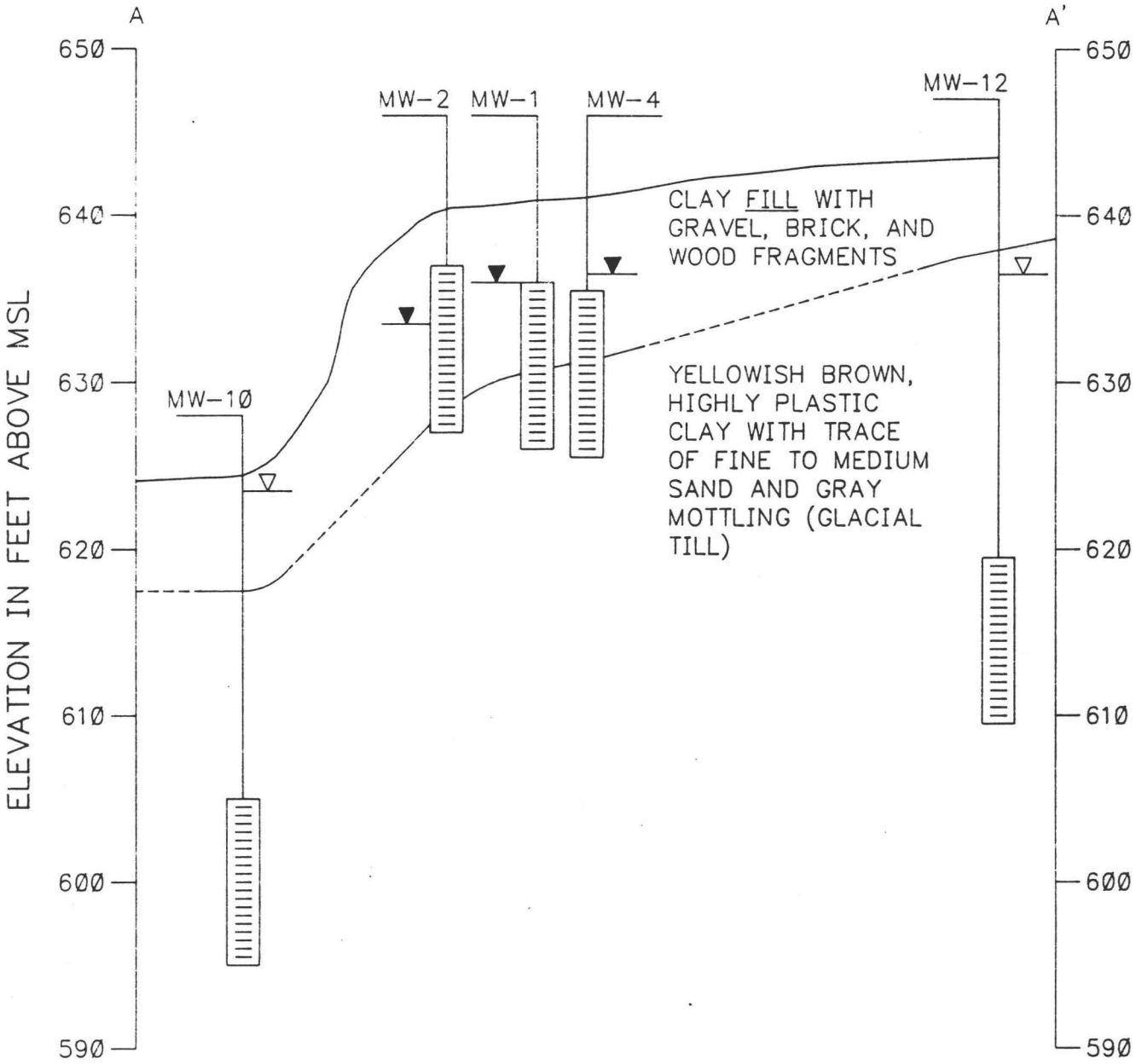
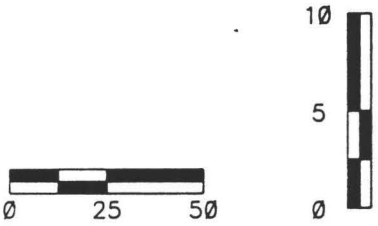
07/17/91 09:14:54





SCALE IN FEET
VERTICAL EXAGGERATION: 5X

NOTES:

1. WATER LEVELS MEASURED ON MAY 30, 1991
2. SEE FIGURE 2 FOR LOCATION OF CROSS SECTION

LEGEND:

▽ WATER LEVEL IN WELLS COMPLETED IN TILLS

▼ WATER LEVEL IN WELLS COMPLETED IN FILL MATERIAL

UNITED TECHNOLOGIES CORPORATION
KEOKUK, IOWA

Woodward-Clyde Consultants
Engineers, Geologists, And Environmental Scientists

GEOLOGIC CROSS SECTION A-A'

DRAWN: M.A.L.	DATE: 06/20/91	PROJECT NUMBER	FIG. NO.
CHECKED: JF	DATE: 7/15/91	91C7343	4

ACAD FILE: 91C7343D

M.A.L. ACAD R11 c2
t=1
07/01/91 10:31:49

(636.86)
MW-8

MACHINE SHOP

FACILITY BUILDINGS

30,000 GALLON PROPANE TANKS

TOP OF BANK

MW-7
(628.38)

(634.32)
MW-5

636

(636.30)

MW-12

TOLUENE TANK

630

634

FORMER TANKS EXCAVATION

APPROXIMATE LOCATION OF FORMER PRODUCT LINE

COOLING POND

628

CHEMICAL STORAGE BLDG.

MW-3

MW-9
(624.75)

626

MW-4

MW-1

632

TOE OF SLOPE

624

MW-2

8 IN. ø CMP

MW-6B
MW-6A

MW-10

(634.25)

24 IN. ø CMP

(623.36)

BURIED PIPE LINES

12 IN. ø CMP

36 IN. ø RCP

24 IN. ø CMP

18 IN. ø CMP

(622.52)
MW-11

EMPLOYEE PARKING LOT

LEGEND:

- RAILROAD TRACK
- MW-6A LOCATION OF EXISTING MONITORING WELLS
- MW-9 LOCATION OF NEW MONITORING WELLS INSTALLED IN MAY, 1991.
- PROPOSED NEW UPPER TILL WELLS
- --633-- WATER LEVEL CONTOUR IN FEET ABOVE MSL
- APPROXIMATE DIRECTION OF GROUNDWATER FLOW

NOTES:
1. WATER LEVELS SHOWN IN PARENTHESES MEASURED IN FEET ABOVE MSL ON 05/30/91.
2. CMP – CORRUGATED METAL PIPE
3. RCP – REINFORCED CONCRETE PIPE

N

50 0 50 100
SCALE FEET

FORMER SHELLER – GLOBE FACILITY
KEOKUK, IOWA

Woodward–Clyde Consultants
Engineers, Geologists, And Environmental Scientists

WATER LEVEL CONTOUR MAP
IN UPPER TILL WELLS

DRAWN: D.D.S.	DATE: 06/19/91	PROJECT NUMBER	FIG. NO.
CHECKED: QA	DATE: 7/17/91	91C7343	5

ACAD FILE: 91C7343C

ACAD FILE: UTC-851 (XREF)
M.A.L
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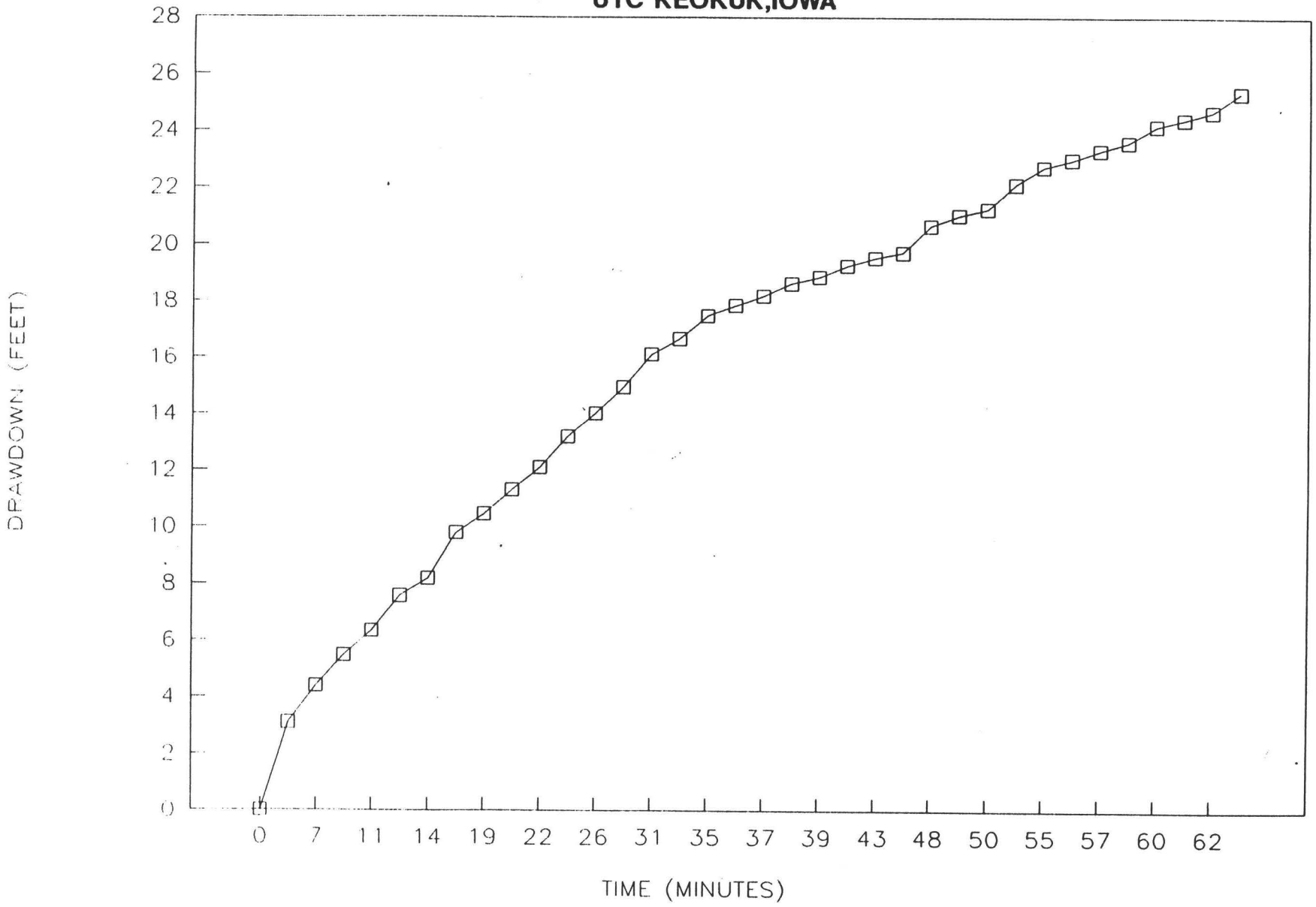
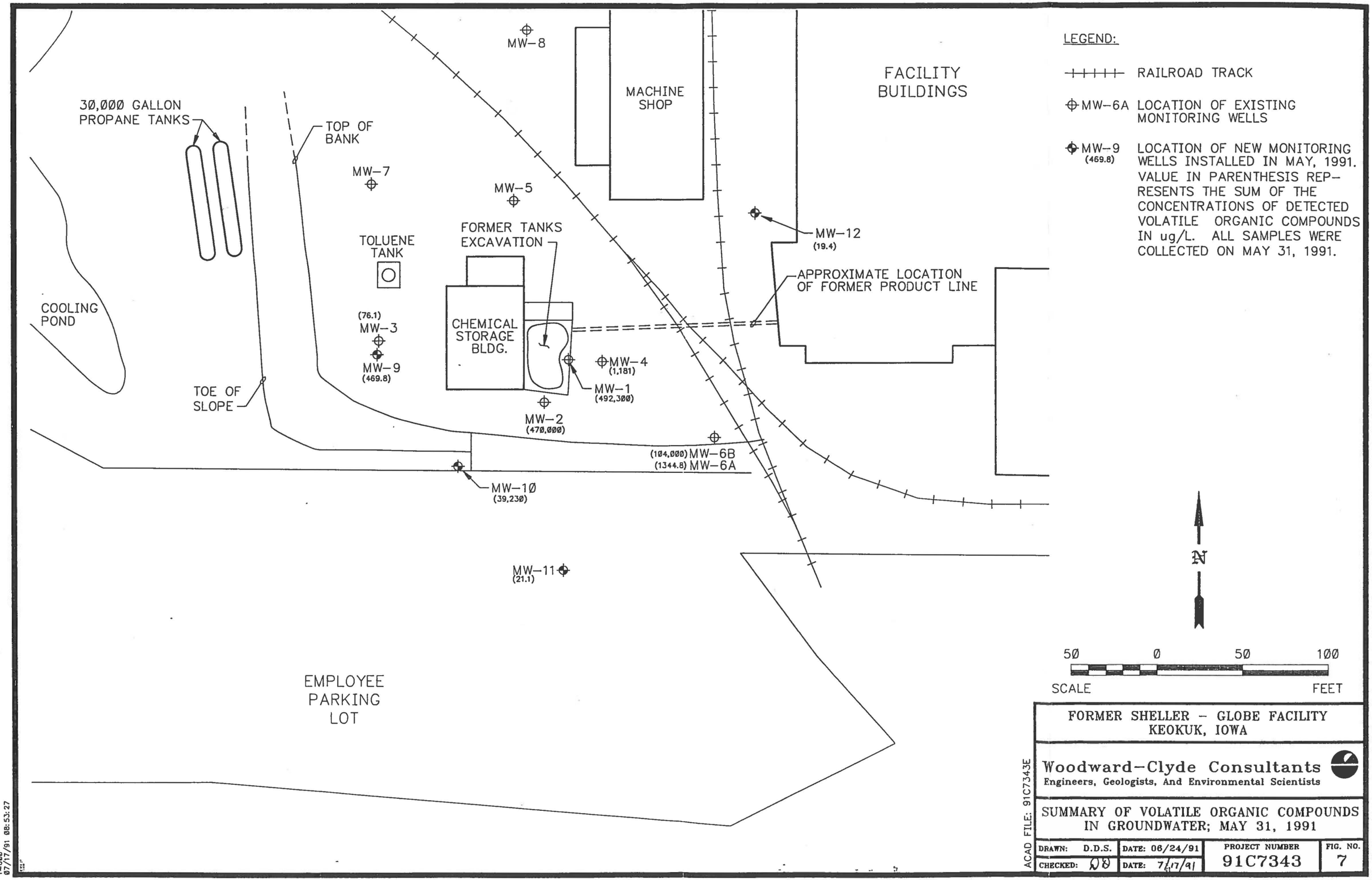
FIGURE 6
PUMP TEST DRAWDOWN CURVE
WELL MW-10
UTC KEOKUK,IOWA





FORMER SHELLER – GLOBE FACILITY
KEOKUK, IOWA

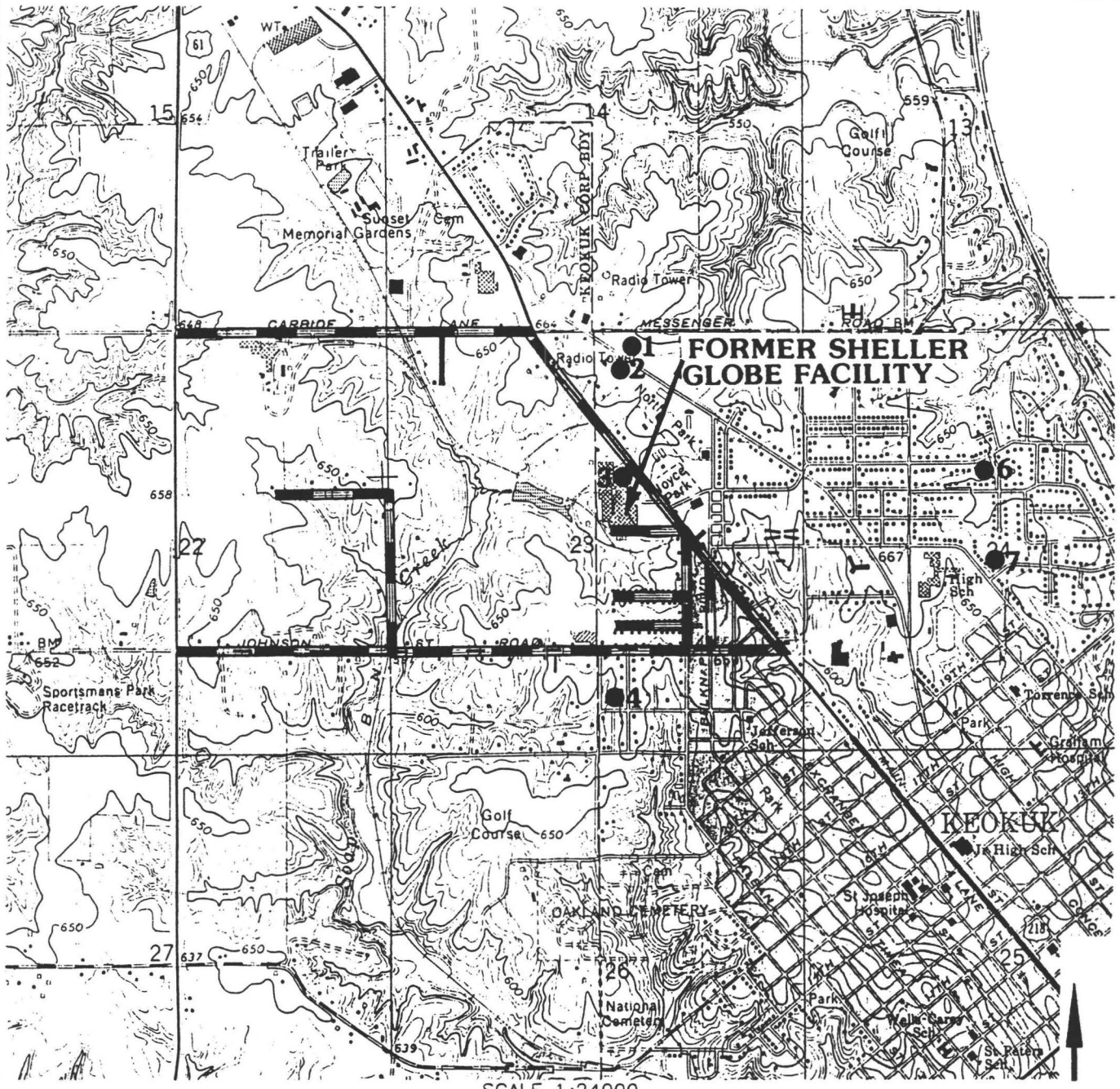
Woodward–Clyde Consultants
Engineers, Geologists, And Environmental Scientists

SUMMARY OF VOLATILE ORGANIC COMPOUNDS IN GROUNDWATER; MAY 31, 1991

DRAWN: D.D.S.	DATE: 06/24/91	PROJECT NUMBER	FIG. NO.
CHECKED: DD	DATE: 7/17/91	91C7343	7

ACAD FILE: 91C7343E

ACAD FILE: UTC-BS1 (XREF)
M.A.L. ACAD R11 c2
1=600
07/17/91 08:53:27



LEGEND:

- ● APPROXIMATE LOCATION OF POTENTIAL WATER WELL
- ▬ PORTION OF CITY DISTRIBUTION LIST SURVEYED

Refer to Table 8 for Description of Potential Wells

FORMER SHELLER – GLOBE FACILITY
KEOKUK, IOWA

Woodward–Clyde Consultants
Engineers, Geologists, And Environmental Scientists

WELL SURVEY LOCATION

DRAWN: DDS	DATE: 1-4-91	PROJECT NUMBER	FIG. NO.
CHECKED: CJF	DATE: 1-15-91	91C7343	8

APPENDIXES

APPENDIX A
PHASE III SITE ASSESSMENT WORK PLAN

Project No. 2969/UTSHE2

Phase III Site Assessment Work Plan
Subsurface Investigation
Former Sheller-Globe Facility
3200 Main Street
Keokuk, Iowa

Prepared for:

Sheller-Globe Corporation
c/o United Technologies Automotive
1641 Porter Street
Detroit MI 48216

February 22, 1991

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LIST OF FIGURES

LIST OF APPENDICES

1.0 - INTRODUCTION

This document constitutes the detailed work plan for conducting a Phase III assessment of a former underground tank facility previously situated at the former Sheller-Globe Corporation facility located at 3200 Main Street in Keokuk, Iowa. The objective of the investigation is to determine the extent of soil and ground-water contamination in the vicinity of the five removed underground storage tanks (UST's) formerly located in the southwestern portion of the property.

The scope of the Phase III work plan was formulated on the basis of the findings of the Phase II site investigation conducted in November of 1990 and in accordance with the comments contained in the January 11, 1991, letter issued by the Iowa Department of Natural Resources (IDNR). More specifically, the Phase III work plan focuses on:

1. Further evaluation of ground-water contamination hydraulically down-gradient of the UST excavation and potentially related areas of soil contamination.
2. Further evaluation of shallow soil contamination in the vicinity of the former UST system and the area surrounding monitoring well MW-6(AB).
3. Investigation of potential conduits for contaminant migration.
4. Qualitative evaluation of the possibility of contaminant sources other than the former UST's.
5. Further evaluation of the stratigraphy and aquifer characteristics in the study area.

Although the Phase II study extended into the area north of the former UST system resulting in the detection of low levels of contaminants in the

shallow soil, the Phase III investigation will not evaluate the area further for the following reason. It was discovered after conducting the Phase II investigation that the IDNR Underground Storage Tank Section had previously granted permanent closure status in a letter dated December 13, 1988, to the UST system located just north of the five UST's (refer to Figure 1) that is the primary focus of this investigation. In hindsight, the suite of compounds found in the shallow soil sample from boring MW-5 during the Phase II study was probably associated with the closed UST system and not the five UST's to the south. Based upon the available data, the following technical approach will be implemented at the subject site.

2.0 - IN-HOUSE FILE REVIEW

In an attempt to further evaluate the possibility of contaminant sources in the study area other than the former UST's, Sheller-Globe Corporation will conduct an in-house file review and employee interviews concerning historical management practices for volatile organic compounds (i.e. industrial feed stock, solvents, and wastes). The findings of the review and interviews will be summarized from on-going discussions, memos, and verbal reports from Sheller-Globe.

3.0 - FIELD INVESTIGATION

3.1 - Monitoring Well Locations

In accordance with the findings and recommendations of the Phase II site investigation, additional monitoring wells are proposed at the locations indicated on Figure 2. All of the wells will be screened within the deeper water-bearing zone of the till as described in the Phase II report. At drilling locations at or below the elevation of the slope base which is adjacent to the chemical building, the first water-bearing zone encountered could possibly be hydraulically connected to the deeper water-bearing zone found at other locations. Criteria employed to select the most appropriate well sites included: (1) the locations of suspected or known contaminant source areas, (2) the locations of existing on-site wells with respect to known or suspected source areas, and (3) the need for further definition of the spacial distribution of hydraulic heads. Down-gradient wells will be located:

1. Near existing well MW-3.
2. Southwest of the UST excavation at the bottom of the slope and next to the retaining wall.
3. Due south of the UST excavation and across 31st Street in the parking area.

Actual well locations will be determined when field activities commence and may differ slightly from the proposed locations to avoid utilities and obstructions.

3.2 - Monitoring Well Installation

The wells will be installed in unconsolidated materials through hollow-stem augers of appropriate diameter. The wells will be constructed of schedule 40, flush-jointed PVC riser pipe, with a 10-foot length of machine-slotted screen having 0.010-inch openings. The well directly down-gradient (southwest) of the UST excavation will be 4 inches in diameter to permit potential use as a ground-water recovery well. The remainder of the wells will be 2 inches in diameter.

The annulus between the well and the bore hole will be backfilled to 2 feet above the screen with clean No. 2 silica sand. A minimum 2-foot bentonite seal will be placed above the sand. The remainder of the annulus will be backfilled with bentonite grout or bentonite chips activated with a small quantity of clean water. The wells will be fitted with lockable flush-mounted protective covers. A graphic well log will be prepared for each well. An example of the well construction form is provided in Appendix A. Each well will be developed by surging and bailing to reduce turbidity and improve hydraulic communication between the well and the formation.

On the basis of the Phase II findings, the target depth of the new wells will be either within or at the bottom of the water-bearing zone encountered at MW-5, MW-6, and MW-8, or within or at the bottom of any significant water-bearing sand and gravel seam such as that encountered at MW-7. Due to the potential difficulty in discerning the bottom of the low-permeability water-bearing zone within the till and the probable limited lateral extent of the sand and gravel seam, the wells on top of the slope will have

maximum depths of 45 feet; and wells at the bottom of the slope will have maximum depths of 35 feet.

The new wells will be surveyed to determine top of casing and adjacent ground-surface elevations by a certified surveyor. The survey data, in conjunction with measured water levels, will be used to develop a potentiometric ground-water map across the study area.

3.2.1 - Soil Sampling: In conjunction with the well installations, 2-foot slit-spoon soil samples will be obtained at 5.0-foot intervals throughout the bore holes. However, soil sampling for the well directly down-gradient of the tank excavation will continue at intervals of 2.5 feet below a depth of 10 feet until the boring is terminated. The soil samples will be collected via the standard penetration test (ASTM D1586-84) with split-barrel samplers. The samples will be characterized as to type, color, density or consistency, moisture content, and evidence of staining on log sheets by qualified personnel. The soils will be classified according to ASTM D2488-69, "Description of Soils (Visual-Manual Procedure)". An example of the boring log form is presented in Appendix B.

Each soil sample will immediately be split into two equal parts, one for possible laboratory analysis and one for field screening. The samples for possible laboratory analysis will be placed in pre-cleaned glass jars provided by the laboratory, properly labeled, and placed in coolers with ice. The samples for field analysis will be placed in clean 16-ounce glass jars and screened using a photo-ionization detector (PID) to measure volatile organics in the headspace of the jars. The ambient temperature headspace procedure

is provided in Appendix C. The PID will be calibrated daily according to the manufacturer's specifications.

The sample with the highest headspace instrument response per boring will be submitted to the laboratory to be analyzed for volatile organic compounds (VOC's) as described in Section 4.1. If no volatile organic compounds are detected in the headspace, the sample collected nearest the top of the saturated zone will be submitted to the laboratory.

A chain-of-custody record will accompany all samples to the laboratory and will serve to cross-reference the sample number and sample location as well as document custody. A typical chain-of-custody record is shown in Appendix D. A copy of each chain-of-custody record will be kept in the project file.

Additional soil sampling will be conducted at a number of other locations as shown on Figure 3. The holes will be advanced by augering to a depth of 10 feet, and samples will be obtained and selected for VOC analysis as described above. Soil samples will be collected at three borings located along the accessible sides of the UST excavation for the purpose of identifying and quantifying the contamination immediately next to the suspected source. Soil samples will be collected at four borings (including one of the preceding three) along the location of the former UST product pipeline for the purpose of identifying and quantifying potential contamination in the soils in this area. Additionally, three soil borings will be installed within 20 feet of monitoring well location MW-6(AB). The borings will be located to the west, north, and east (if feasible). Samples collected

at these locations will help to determine the lateral extent of the soil contaminants identified in this area during the Phase II investigation.

To prevent cross-contamination during the soil sampling and well installation activities, sampling tools will be decontaminated before the first sample, between each sample, and after the last sample by: (1) scrubbing with potable water and Alconox, (2) rinsing with potable water, and (3) rinsing with Type I deionized water.

Drilling tools (i.e. augers and drill rods) will be decontaminated before the first boring, between borings, and after the last boring using a steam or high-pressure hot water cleaner. The runoff generated by the decontamination process will be contained and stored in large polyethylene tanks until final disposition of all used decontamination solutions is determined at the completion of the project. Disposal will be conducted in accordance with all applicable state and federal regulations.

All auger cuttings and excess soil generated during the above drilling and well installation activities will be stockpiled at the site. The stockpile will be underlain and securely covered by heavy-gauge plastic sheeting pending completion of the soil analyses and decision regarding final disposition. Disposal will be conducted in accordance with all applicable state and federal regulations.

3.2.2 - Ground-Water Sampling: Ground-water samples will be obtained from the three new ground-water monitoring wells and existing wells MW-1 through MW-4 and MW-6(AB). Prior to sampling, the static water level will be measured in feet below the top of the north side of the well riser (inner casing) elevation to an accuracy of 0.01 feet using an

oil/water interface probe. The measurement and observations will be recorded on the Well Sampling Data Log. A copy of the Well Sampling Data Log is shown in Appendix E.

Following measurement and recording of the static water level, the depth to the bottom of the well and the diameter of the well will be confirmed and the static volume of water in the well will be calculated. The interface probe and other objects entering the well will be decontaminated before use in any other well. The decontamination procedure will consist of an Alconox wash, followed by a potable-water rinse, and a final Type I deionized-water rinse.

The wells will be purged prior to sampling using the following method. Three well volumes will be removed from each well using a disposable bailer. During the purging process, the temperature, pH, and conductivity of the water will be measured. When these three parameters "stabilize" and a minimum of three volumes have been removed, the water being purged will be considered representative of aquifer conditions. The purge water will be stored in large polyethylene tanks prior to proper disposal.

Wells having a slow recharge rate (i.e. requires 24 or more hours to recharge to its pre-purge level) will be bailed dry. Each monitoring well will be allowed to recharge sufficiently prior to sampling. Samples will be obtained within 24 hours after purging if sufficient recharge exists. If recharge is not rapid enough to provide sufficient volume for analysis, additional ground water may be collected as recharge permits. If recharge to the well is sufficiently fast, ground-water samples will be obtained immediately after purging. Information such as the method of purging, time

of day, volume of water purged, temperature, pH, specific conductance, and other information will be recorded on the Well Sampling Log.

Collection of water samples from the wells will be performed using pre-decontaminated and sealed single-use polyethylene bailers. The bailer will be lowered down the well and allowed to submerge to a depth near the top of the static water level. The bailer will then be removed from the well and the water transferred to laboratory-cleaned, 40 milliliter (ml) volatile organic analysis sample vials. The vials will then be immediately sealed with caps which have Teflon septums, labeled, placed in iced storage, and shipped to the analytical laboratory. The samples will be delivered to the laboratory within 24 hours using the chain-of-custody procedures outlined in the previous section. The ground-water samples will be analyzed according to the procedures described in Section 4.2.

3.2.3 - In-Situ Hydraulic Conductivity Testing: Once the wells at the site have reached static water-level conditions, "slug" tests will be performed at two of the new down-gradient wells in order to obtain data for the potential design of a remediation system.

Depending on the well diameter and height of water in the well, a cylinder of known volume will be quickly lowered beneath the water surface causing a rapid rise in the water level. The water level will be allowed to recover to at least 80% of the static water level before ending the test. The rates of recovery of the water level will be recorded by a data logger attached to a pressure transducer previously installed in the well. If time allows, the "slug-in" test will immediately be followed by a "slug-out" test

conducted by the rapid removal of the cylinder and recording of the recovery of the lowered water level to static conditions.

The transducer and slugs will be decontaminated between wells using an Alconox detergent wash followed by potable Type I deionized water rinses. Fluids will not be added to the monitoring wells during the tests, thus minimizing the potential for ground-water quality impact.

The hydraulic conductivity of the material in the immediate vicinity of each monitoring well will be estimated from the data using the method of Cooper et al. (1967). The hydraulic conductivity estimates will be used to perform a capture-zone analysis (CZA) for use in a preliminary evaluation of ground-water remediation alternatives.

4.0 - LABORATORY ANALYSIS

4.1 - Soil Analysis

The soil samples collected during the field investigation will be submitted to the laboratory for analysis of volatile organic compounds by EPA SW-846 Method 8240. Most of the volatile organic compounds routinely have a detection limit of 5 ug/kg or parts per billion (ppb). However, the volatile gases normally have 10 ppb detection limit; and the ketones typically have a detection limit of 100 ppb. For quality control purposes, one sample for every 20 soil samples collected will be analyzed in duplicate.

4.2 - Ground-Water Analysis

The ground-water samples collected during the investigation will be submitted to the laboratory for analysis of volatile organic compounds by EPA Method 8240. Previous analyses indicate certain compounds were present in the ground water. The list below represents the compounds of greatest interest and the detection limits which are typically achieved.

Benzene	5 ppb	Ethylbenzene	5 ppb
Toluene	5 ppb	Xylenes	5 ppb
Methylene Chloride	5 ppb	MEK	100 ppb

For quality control purposes, one ground-water sample will be submitted to the laboratory in duplicate. In addition, one trip blank will accompany each shipment of samples to ensure quality control.

5.0 - DATA ANALYSIS & REPORT

Physical and chemical data obtained during the investigation will be reduced in a variety of ways to facilitate interpretation and presentation. The following data reduction and analysis activities will be performed in conjunction with preparation of the investigation report:

1. Geologic Cross Section - One geologic cross section oriented approximately parallel to the prevailing ground-water gradient will be prepared from subsurface data obtained during this and previous phases of the site investigation.

2. Ground-Water Contouring - The distributions of hydraulic head will be plotted in plan and cross section and a map of the ground-water potentiometric surface developed.

3. Soil Contamination - Soil contaminant concentrations will be illustrated on the base map of the study area.

4. Ground-Water Contamination - Ground-water contaminant concentrations will be illustrated on the base map of the study area.

At the conclusion of the field work, laboratory analysis, and data analysis, a report will be prepared describing field and analytical methods, field and laboratory data, findings, and conclusions regarding the distribution of contaminants at the site. The report will contain all field documentation such as chain-of-custody reports, boring logs, well installation diagrams, and sampling data sheets. A copy of the final report and supporting documentation (i.e. calculations, maps, etc.) will be submitted to the IDNR upon its completion.

The report will include a brief discussion of remediation alternatives for soil and ground water. The data collected during the Phase II and Phase III studies will assist in determining the feasibility of recovering the contaminated ground water in the glacial till formation. Subsequent to collection and evaluation of the appropriate data, Sheller-Globe will develop proposed soil cleanup standards for this site. The methodology and rationale for these proposed standards will be provided to the IDNR.

6.0 - SCHEDULE

The following is a generic schedule for implementing the proposed work plan.

Day	Task
2-18-91	Submit work plan to IDNR.
0-14	Mobilization after IDNR approval.
14-34	Subsequent to IDNR approval, conduct field activities outlined in the work plan.
34-94	Analytical testing and preparation of site investigation report.
94-124	Submit the site investigation report to the IDNR for review.

LLT\FEB91\2969.REP

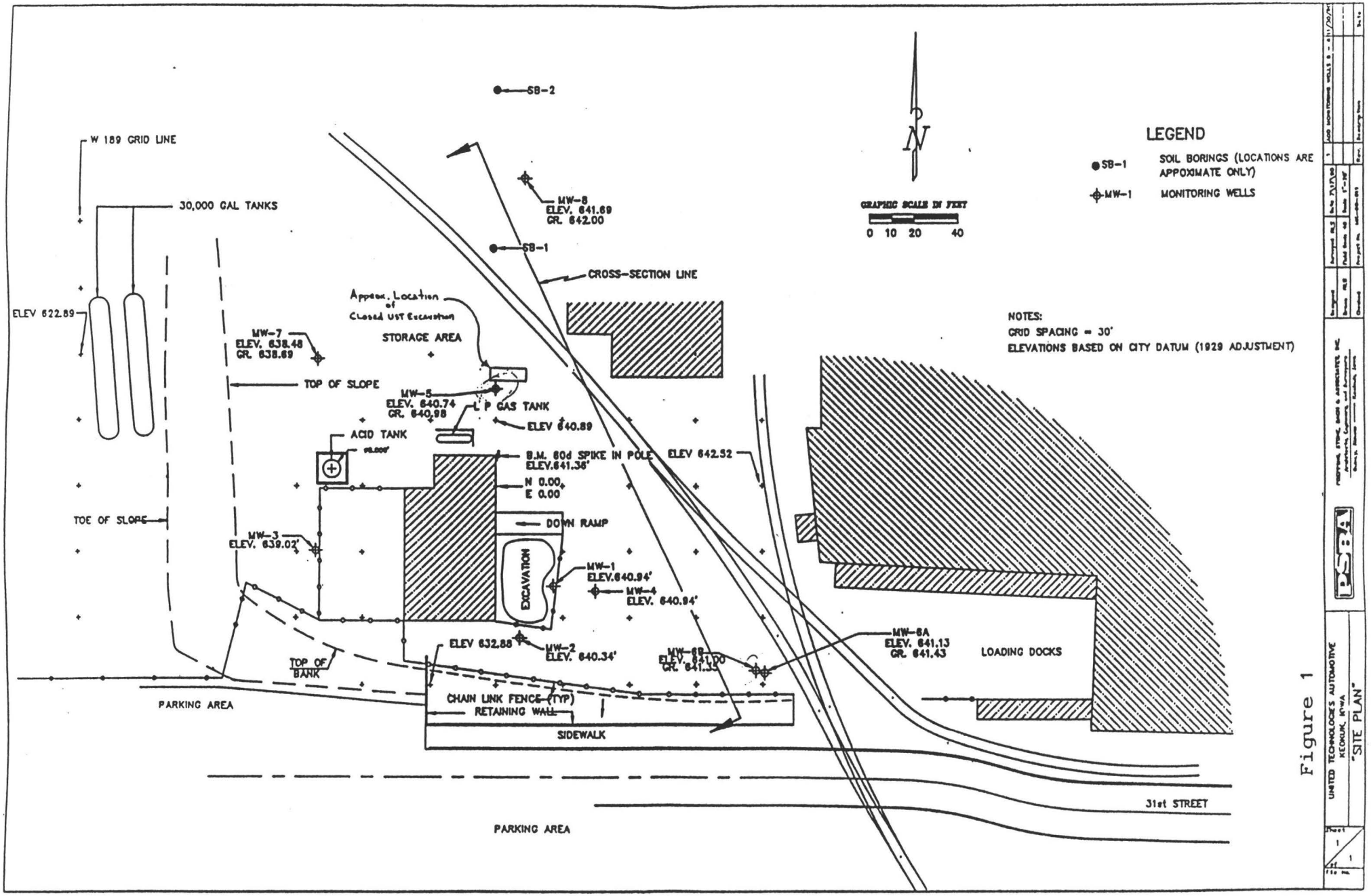

SB-2
W 189 GRID LINE
30,000 GAL TANKS
MW-8
ELEV. 641.69
GR. 642.00
SB-1
CROSS-SECTION LINE
ELEV 622.89
Approx. Location of Closed UST Excavation
STORAGE AREA
MW-7
ELEV. 638.48
GR. 638.89
TOP OF SLOPE
MW-5
ELEV. 640.74
GR. 640.98
L P GAS TANK
ELEV 640.89
ACID TANK
B.M. 60d SPIKE IN POLE
ELEV.641.36'
N 0.00,
E 0.00
ELEV 642.52
TOE OF SLOPE
MW-3
ELEV. 639.02'
DOWN RAMP
EXCAVATION
MW-1
ELEV.640.94'
MW-4
ELEV. 640.94'
ELEV 632.88
MW-2
ELEV. 640.34'
MW-6B
ELEV. 641.20
GR. 641.33
MW-6A
ELEV. 641.13
GR. 641.43
LOADING DOCKS
TOP OF BANK
PARKING AREA
CHAIN LINK FENCE (TYP)
RETAINING WALL
SIDEWALK
31st STREET
PARKING AREA
N
GRAPHIC SCALE IN FEET
0 10 20 40
LEGEND
SB-1 SOIL BORINGS (LOCATIONS ARE APPOXIMATE ONLY)
MW-1 MONITORING WELLS
NOTES:
GRID SPACING = 30'
ELEVATIONS BASED ON CITY DATUM (1929 ADJUSTMENT)
UNITED TECHNOLOGIES AUTOMOTIVE
KEOKUK, IOWA
"SITE PLAN"

Figure 1

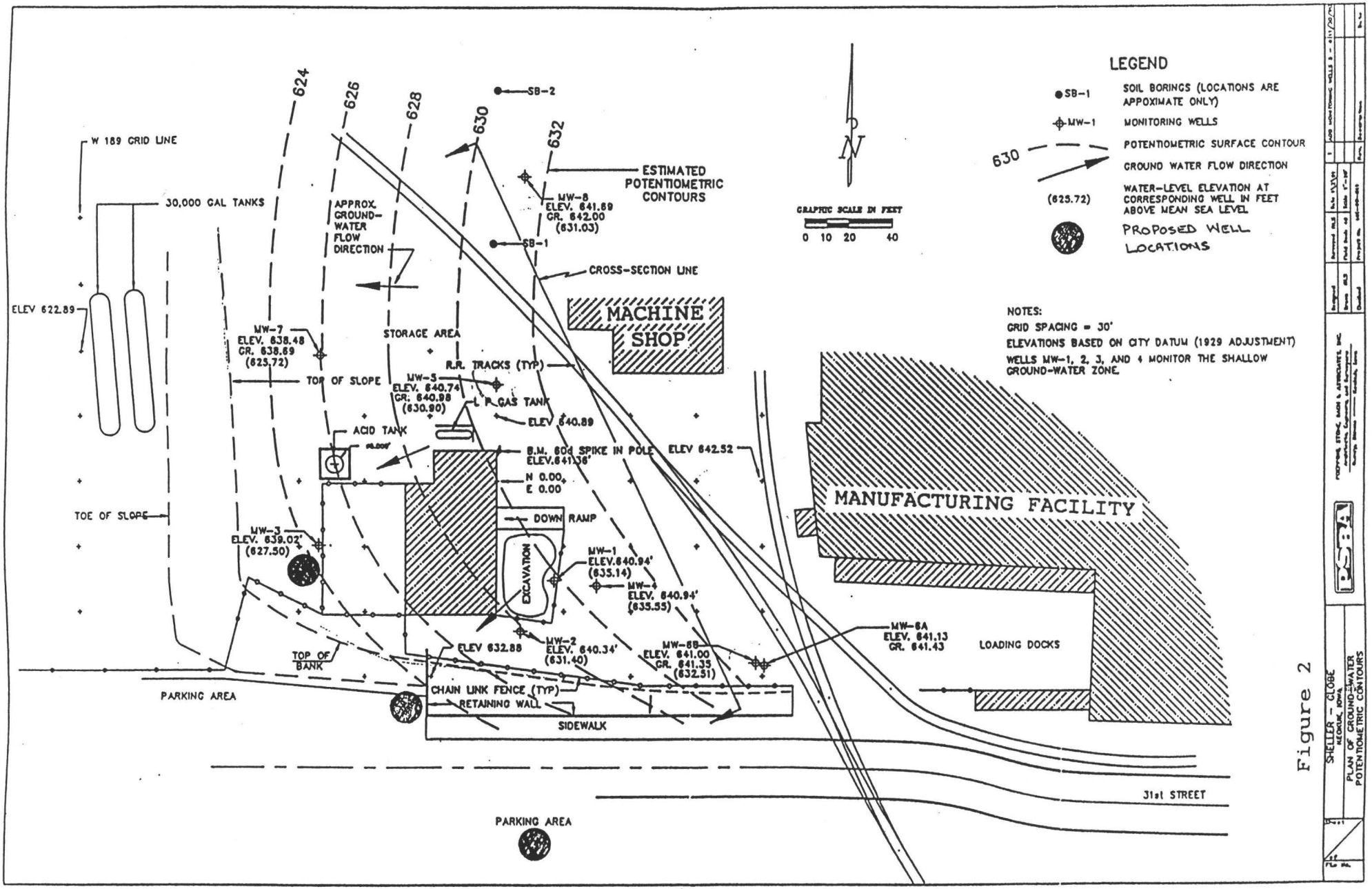


Figure 2

SHELLER - GLOBE
NEOGUK, IOWA
PLAN OF GROUND-WATER POTENTIOMETRIC CONTOURS

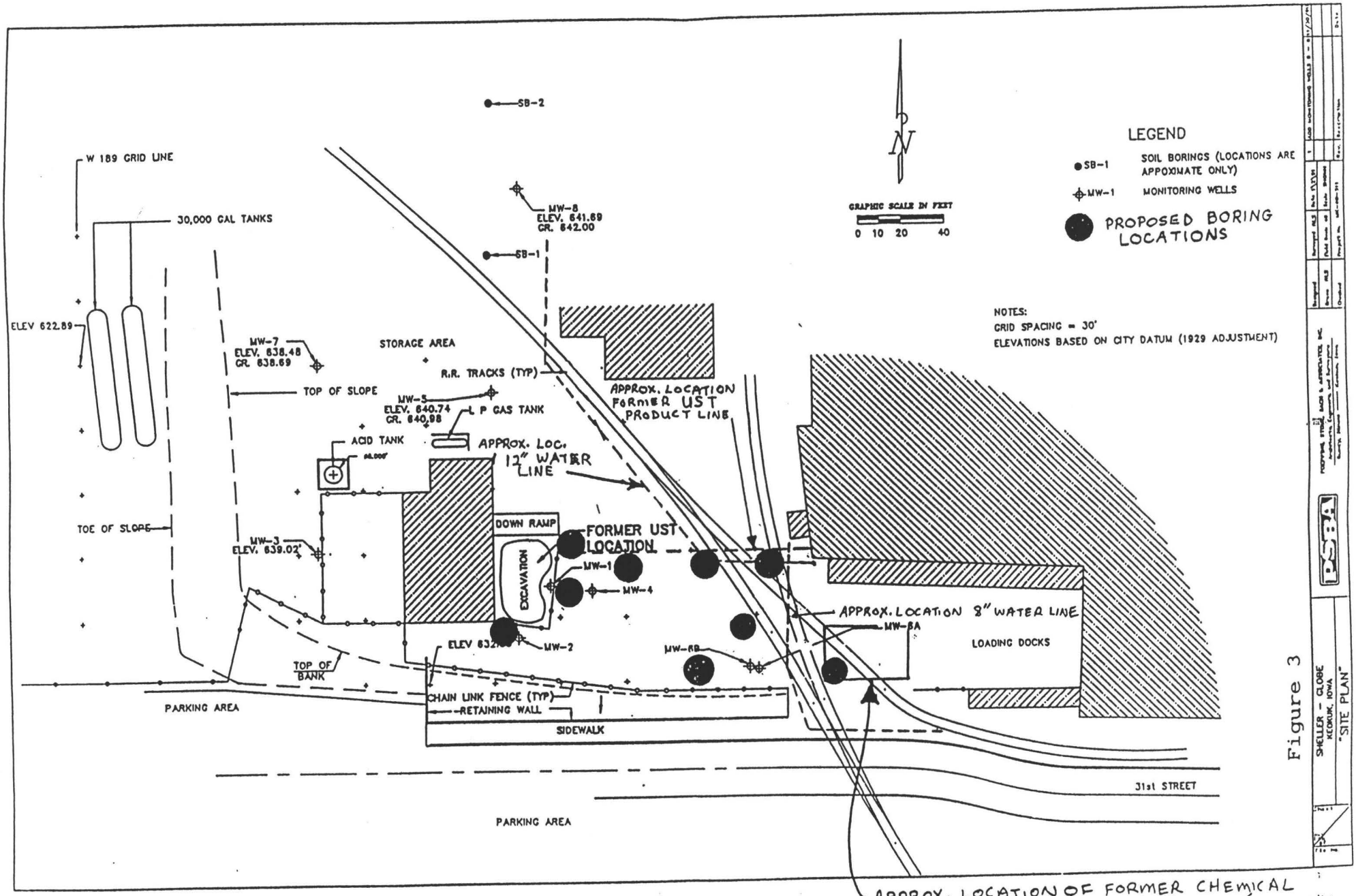

SB-2
W 189 GRID LINE
30,000 GAL TANKS
MW-8
ELEV. 641.69
GR. 642.00
SB-1
ELEV 622.89
MW-7
ELEV. 638.48
GR. 638.69
STORAGE AREA
R.R. TRACKS (TYP)
TOP OF SLOPE
MW-5
ELEV. 640.74
GR. 640.98
L P GAS TANK
ACID TANK
APPROX. LOC. 12" WATER LINE
APPROX. LOCATION FORMER UST PRODUCT LINE
TOE OF SLOPE
MW-3
ELEV. 639.02
DOWN RAMP
FORMER UST LOCATION
EXCAVATION
MW-1
MW-4
MW-2
APPROX. LOCATION 8" WATER LINE
MW-8A
LOADING DOCKS
MW-8B
TOP OF BANK
CHAIN LINK FENCE (TYP)
RETAINING WALL
SIDEWALK
PARKING AREA
31st STREET
PARKING AREA
N
GRAPHIC SCALE IN FEET
0 10 20 40
LEGEND
SB-1 SOIL BORINGS (LOCATIONS ARE APPOXIMATE ONLY)
MW-1 MONITORING WELLS
PROPOSED BORING LOCATIONS
NOTES:
GRID SPACING = 30'
ELEVATIONS BASED ON CITY DATUM (1929 ADJUSTMENT)
SHELLER - GLOBE
KEOKUK, IOWA
"SITE PLAN"
APPROX. LOCATION OF FORMER CHEMICAL STORAGE AND MIXING BUILDING (REMOVED ABOUT 1963).

Figure 3

Appendix A

Well Construction Form

Date of Installation _____

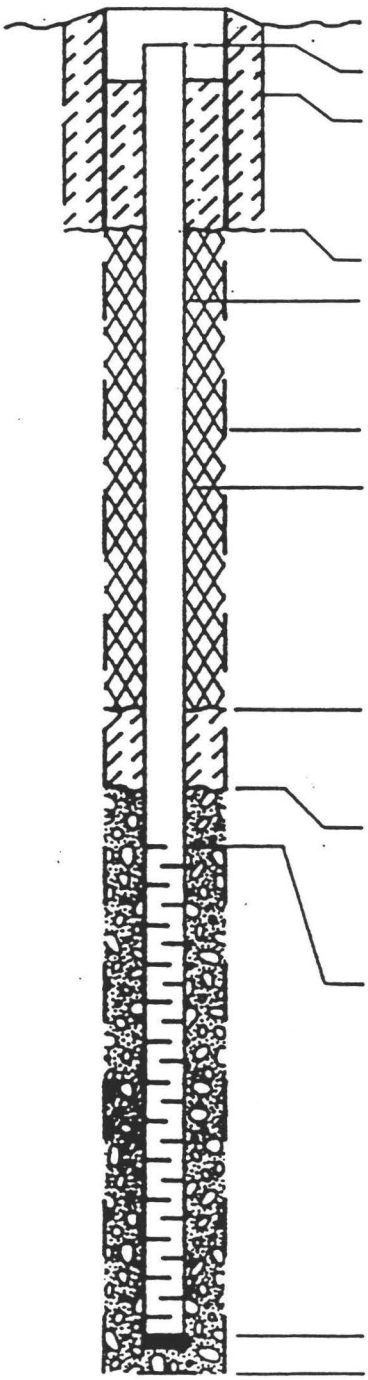
Drilling Company _____

Drilling Method _____

Field Engineer _____

Depth Log Description

0



Ground Surface Elevation _____

Elevation of Top of Riser Pipe _____

I.D. of Protective Casing _____

Type of Protective Casing _____

_____

Depth to Bottom of Vault _____

I.D. of Riser Pipe _____

Type of Riser Pipe _____

_____

Diameter of Borehole _____

Type of Backfill _____

_____

Depth to Top of Seal _____

Type of Seal _____

_____

Depth to Top of Sand Pack _____

Type of Sand Pack _____

_____

Depth to Top of Screen _____

I.D. of Well Screen _____

Type of Well Screen _____

_____

Depth to Bottom of Screen _____

Depth to Bottom of Borehole _____

Ground Water Level

(Depth from Top of Riser) Date Depth

_____ _____

_____ _____

_____ _____

	pcs POLLUTION CONTROL SYSTEMS	Report of Monitoring Well _____	Fig.

Appendix B

Boring Log Form

PROJECT ______________________________ PROJECT NO. ____________

ELEVATION ________ GWL 0 HRS ______________________ BORING NO. ____________

HRS

DATE ____________ FIELD ENGINEER ______________________ PAGE NO. ______ OF ______

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY— CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10

REMARKS** ____

____ PROJECT NO. ____________

BORING NO. ____________

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

Appendix C

Ambient Temperature Headspace (ATH) Procedure

AMBIENT TEMPERATURE HEADSPACE PROCEDURE

1.0 - Objective: To develop a procedure to standardize ATH readings.

2.0 - Personnel: Qualified environmental technician.

3.0 - Procedure: Headspace analysis will be performed daily on soil samples collected during drilling operations. The soil samples most likely will be collected by decontaminated discrete samplers (split spoons) or continuous soil/bedrock samplers.

The sample collection jars (16-ounce glass jars with lids) will be decontaminated between each use by utilizing a Alconox wash, tap water rinse, followed by a Type I deionized water rinse.

During soil sampling, take part of the sample obtained and fill the jar half full. Immediately cover the jar with a double layer of aluminum foil and secure with the screw cap. The half-full jar will create a vacant headspace of approximately 300 ml over a soil sample of approximately 300 grams.

Store the soil-filled sample jars at a temperature range of 40°F to 70°F for 30 minutes. This will allow all samples collected to reach similar temperature ranges prior to analysis. It also allows hydrocarbons to uniformly volatilize from the soil into the container headspace.

The vacant headspace will be sampled by removing the steel lid and retainer ring and piercing the aluminum foil seal with a probe extension connected to the PID. The PID has a built-in fan that draws vapors into the ionization chamber at a rate of 100 ml per minute. At this rate, it will take approximately 3 minutes to completely evacuate the headspace in the sample container.

The PID should reach its peak response within 5 to 10 seconds. Therefore, the headspace reading should be taken between 10 and 15 seconds after piercing the foil seal. This will be long enough for the PID meter to respond but far short of withdrawing enough vapor to affect the vapor equilibrium in the sample container. The resulting PID readings will be in parts per million (ppm) of total ionizable hydrocarbons based on a benzene standard.

4.0 - Equipment: _____ PID/FID

_____ 16 oz. glass jars (pre-cleaned)

_____ aluminum foil

_____ headspace data sheets

5.0 - Reference: Detection of Hydrocarbons in Groundwater by Analysis of Shallow Soil-Gas Vapor, 1985, API.

6.0 - Reporting: Field Volatile Organic Readings

Appendix D

Chain-of-Custody Record

PROJECT NO.: _____

CLIENT: _____

LOCATION: _____

SAMPLED BY: _____

CUSTODY NO.: _____

PROJ. MGR.: _____

CONTACT: _____

CHAIN OF CUSTODY RECORD

CEDAR RAPIDS, IA 319-393-3900

LAOTTO, IN 219-637-3137

SAMPLE NUMBER	DATE	TIME	SAMPLE IDENTIFICATION	MATRIX	COMPOSITE OR GRAB	FIELD MEASUREMENTS	NO. OF CONTAINERS	ANALYSIS REQUIRED							REMARKS (PRESERVATION, ETC.)

Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)

Remarks:

Appendix E

Well Sampling Data Log

WELL SAMPLING DATA LOG

Project_____ Field Person_____

Date_____ Time_____

Well No._____ Sample No._____

Weather_____(_____°F)

Sampling Method_____

Aquifier Sampled_____ Confined/Unconfined_____

Well Information:

Depth of Well_____(feet)

Interval Sampled_____

Diameter of Well_____(inches) Material_____

Original Depth to Water (DTW)_____(feet)

Final DTW Prior to Sample_____(feet)

One Casing Volume_____

Water Volume Removed_____

Estimated Casing Volumes Removed_____

Final Field Parameters:

Appearance_____

Odor_____

Water Temperature_____°C

Specific Conductance_____M/MHOS/CM@25°C

pH_____

Volume Purged	Temp. (°C)	Ph	(Cond)
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

PCS Lab_____

Outside Lab_____

Date Shipped_____

Container Lot #_____

Comments:_____

POLLUTION CONTROL SYSTEMS, INC.
2337 Blairs Ferry Rd. N.E.
Cedar Rapids, Iowa 52402

Attachment II

PCS®

PROJECT UTA SITE ASSESSMENT — PROJECT NO. 2430/UTASHE

GROUND ELEVATION 640.98 — GWL 0 HRS ____ HRS — BORING NO. MW-5

DATE 11/5/90 — FIELD ENGINEER W.H. ROBINSON — PAGE NO. 1 OF 1

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	ROD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY—CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
				1.0			ASPHALT & BC		
					MED. STIFF	BRN-GRY	FILL - SILTY CLAY W/ TRACE	CH	MOIST. SOME BLACK
	2						SAND, TRACE ROCK FRAGS.,		STAINING AND FE
	2 4	OS-1					SOME BRICK FRAGMENTS		STAINING.
5.0									
	5 3	OS-2				GRN-GRY & BRN			VERY MOIST.
	5								
7.5					STIFF		- SILTY CLAY TO CLAYEY	CH/MH	VERY MOIST.
	5 6	OS-3					SILT, TRACE SAND, TRACE		
10.0				10.0			ROCK FRAGMENTS		VERY MOIST.
	4 6	OS-4				GRY & YW-BRN	TILL - SANDY SILTY CLAY W/	CH	MOIST. MOTTLED.
	8						TRACE ROCK FRAGMENTS,		AUGERS TURNING
							SOME SMALL BLACK		SLOWLY.
							NODULES		
15.0									MOIST. GREY
	5 6	OS-5					- BECOMING SLIGHTLY		MOTTLES ARE
	7						SANDIER		MOSTLY VERTCALLY
									ORIENTED LIKE
									FRACTURE FILLINGS.
20.0							- SANDY, CLAYEY SILT, W/	MH	
	6 10	OS-6			VERY STIFF		SOME ROCK FRAGMENTS,		VERTICAL, GREY
	14						SOME SMALL BLACK NOD-		MOTTLES BECOMING
							ULES		SANDIER.
25.0							- INCREASING COARSE		
	7 11	OS-7					SAND CONTENT		
	10								
30.0									
	7 11 7	OS-8					BOH 31.5 FT		

REMARKS: 6 5/8" (ID) HOLLOW-STEM AUGERS 0.0 - 30.0, SPT TO 31.5 FT

DRILLERS: LATTA & SONS, P. LATTA & K. KIENE — RIG: TRUCK-MOUNTED CME 55 — PROJECT NO. 2430/UTASHE — BORING NO. MW-5

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

PROJECT UTA SITE ASSESSMENT — PROJECT NO. 2430/UTASHE

GROUND ELEVATION 641.43 / 641.35 — GWL 0 HRS ____ HRS — BORING NO. MW-6A,B

DATE 11/6/90 — FIELD ENGINEER W.H ROBINSON — PAGE NO. 1 OF 1

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY—CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
0.0				1.0			CONCRETE & BC		
					SOFT	DK BRN TO BLK	FILL - CLAYEY SILT W/ TRACE	MH	VERY MOIST.
2.5							SAND, FEW ROOTS		
	1 2 2	OS-1							
5.0						BRN			VERY MOIST TO
	1 2 3	OS-2		5.5					SATURATED.
					MED. STIFF	GRY-BRN & YW-BRN	TILL - CLAY W/ TRACE TO SOME	CH	SATURATED.
7.5							SILT, TRACE SAND		SLIGHTLY MOTTLED
	3 6 8	OS-3			STIFF	GRY & YW-BRN	- CLAY W/ TRACE TO		VERY MOIST.
10.0							SOME SILT, SOME SAND		STRONG MOTTLING.
	6 7 9	OS-4			VERY STIFF		TRACE ROCK FRAGS.		GREY MOTTLES HAVE
									VERTICAL ORIENTA-
				13.0					TION LIKE FRACTURE
							- SILTY CLAY TO CLAYEY	MH TO CL	FILLINGS. GREY
15.0							SILT, W/ SOME SAND, TRACE		MOTTLES HAVE
		OS-5					TO SOME ROCK FRAGS.,		HIGHER SAND CON-
									TENT. MOIST.
									BLACK OXIDATION
									COATING MOST ROCK
20.0									FRAGMENTS.
	11 12 13	OS-6							STRONG MOTTLING.
									AUGERS TURNING
				23.0					SLOWLY.
						YW-BRN	- SILT W/ SOME CLAY,	ML	SLIGHTLY MOIST.
25.0							SOME SAND, TRACE ROCK		
	7 14 14	OS-7					FRAGS.		
						YW-BRN & GRY			FEWER MOTTLES.
									SATURATED. GREY
30.0									MOTTLES ARE WET
	9 10	OS-8					BOH 31.5 FT		AND SANDIER.

REMARKS** 4¼-INCH (ID) HOLLOW-STEM AUGERS 0-30.0 FT, SPT TO 31.5 FT.

DRILLERS: LATTA & SONS, P. LATTA & K. KIENE RIG: TRUCK-MOUNT CME 55

PROJECT NO. 2430/UTASHE

BORING NO. MW-6A,B

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

PROJECT UTA SITE ASSESSMENT — PROJECT NO. 2430/UTASHE

GROUND ELEVATION 638.69 GWL 0 HRS / HRS — BORING NO. MW-7

DATE 11/6/90 — FIELD ENGINEER WH ROBINSON — PAGE NO. 1 OF 2

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY—CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
0.0				1.0			ASPHALT & BC		
					MED. STIFF	BRN & GRY	FILL - CLAYEY SILT W/ SOME	ML H	V. MOIST.
2.5							SAND		
	3 3 3	OS-1							
5.0									
	2 3 4	OS-2					- SILTY CLAY W/ SOME	CL TO CH	V. MOIST.
							SAND		
						GRN GRY & YW-BRN	- SAME W/ TRACE TO		
							SOME SAND		
10.0									
	3 3 3	OS-3							
				13.0					
					STIFF	GRY & YW-BRN	TILL - SANDY, CLAYEY SILT W/	ML TO MH	MOIST. MOTTLED.
15.0							TRACE TO SOME ROCK		GREY MOTTLES HAVE
	6 6 6	OS-4					FRAGS.		HIGHER SAND CON-
									TENT AND MANY
									ARE VERTICALLY
									ORIENTED LIKE
20.0					VERY STIFF				FILLED FRACTURES.
	12 12 18	OS-5							MOIST.
									AUGERS TURNING
									SLOWLY.
25.0									
	7 14 19	OS-6			HARD		- SAME W/ SOME		FEWER MOTTLES,
							ROCK FRAGMENTS.		SOME GREY MOTTLES
									APPEAR WET, BUT
									TILL IS GENERALLY
30.0									ONLY MOIST.

REMARKS** 4¼" (ID) HOLLOW-STEM AUGERS 0.0 - 40.0 FT, SPT TO 41.0 FT.

DRILLERS: LATTA & SONS, P. LATTA & K. KIENE — RIG: TRUCK-MOUNTED CME 55 — PROJECT NO. 2430/UTASHE — BORING NO. MW-7

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

PROJECT UTA SITE ASSESSMENT — PROJECT NO. 2430/UTASHE

ELEVATION _____ GWL 0 HRS _____ HRS — BORING NO. MW-7

DATE 11/7/90 FIELD ENGINEER WH ROBINSON — PAGE NO. 2 OF 2

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	RQD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY—CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
0.0	8/14/17	OS-7			HARD	GRY & YW-BRN	TILL - SANDY, CLAYEY SILT	ML TO MH	MOIST.
					↓		W/ SOME ROCK FRAGS.		
2.5	7/9/15	OS-8			VERY STIFF				
35.0	6/15/12	OS-9							SPLIT-SPOON CAME UP WET, BUT SAMP ONLY VERY MOIST. GREY SANDY MOTTLE ARE SATURATED.
					↓	↓	↓	↓	
40.0	43/45	OS-10			VERY DENSE	BRN & GRY-BRN	SAND & GRAVEL W/ TR TO SOME SILT, FEW THIN CLAY SEAMS	SW TO GW	
					↓	↓	↓	↓	
							BOH 41.0 FT		

REMARKS** _____

PROJECT NO. 2430/UTASHE

BORING NO. MW-7

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

PCS®

PROJECT UTA SITE ASSESSMENT — PROJECT NO. 2430/UTASHE

GROUND ELEVATION 642.00 GWL 0 HRS ____ HRS — BORING NO. MW-8

DATE 11/7/90 . FIELD ENGINEER WH ROBINSON/F HAUSMAN — PAGE NO. 1 OF 1

DEPTH FEET	BLOWS PER SIX INCHES OR CORE RECOVERY/RUN	SAMPLE NO., TYPE & RECOVERY OR % ROCK RECOVERY	ROD (%)	DESCRIPTION: PROFILE	DESCRIPTION: SOIL DENSITY—CONSISTENCY OR ROCK HARDNESS	DESCRIPTION: COLOR	DESCRIPTION: MATERIAL CLASSIFICATION	USCS OR ROCK BROKENNESS	REMARKS*
1	2	3	4	5	6	7	8	9	10
0.0				1.0			ASPHALT & BC		
	1				VERY SOFT	DK. BRN-GRY	FILL- CLAYEY SILT W/ TRACE	MH	MOIST.
2.5	1						SAND		
	1	OS-1							
5.0				5.0					
	2 3	OS-2			MED. STIFF	DK. BRN	-SILT W/ TRACE CLAY	ML	MOIST. MOTTLED.
	3			7.0					
7.5						BRN	-SILTY CLAY W/ TRACE	CH	MOIST. MOTTLED
	2 4 5	OS-3		9.0	STIFF		FINE GRAVEL		
10.0						BRN & YW-BRN	TILL- SILTY CLAY W/ TRACE		BLACK OXIDE STAINS
	7 9	OS-4			VERY STIFF		ROCK FRAGMENTS,		GREY MOTTLES ARE
	11						TRACE SAND		VERTICALLY ORIENTE
									LIKE FRACTURE
									FILLINGS.
15.0						BRN	-SAME W/ TRACE TO	CH TO CL	LESS BLACK OXIDE
	7 8 9	OS-5					SOME SAND		STAINING.
									GREY MOTTLES
									ARE SANDIER
20.0									THAN SILTY CLAY
	7 12 16	OS-6							MATRIX.
25.0									
	NO RECOVERY								WET SPLIT SPOON
30.0						LT. BRN			
	16 10 16	OS-7					BOH 31.5		

REMARKS** 4¼" (ID) HOLLOW-STEM AUGERS 0.0 - 30.0 FT, SPT TO 31.5 FT

DRILLERS: LATTA & SONS, P. LATTA & K. KIENE — RIG: TRUCK-MOUNTED CME 55 — PROJECT NO. 2430/UTASHE — BORING NO. MW-8

*POCKET PENETROMETER READINGS

**METHOD OF ADVANCING AND CLEANING BORING

APPENDIX B
IOWA DEPARTMENT OF NATURAL RESOURCES COMMENT LETTER

STATE OF IOWA

TERRY E. BRANSTAD, GOVERNOR

DEPARTMENT OF NATURAL RESOURCES
LARRY J. WILSON, DIRECTOR

March 15, 1991

Mr. Brian J. Yeich
Corporate Environmental Scientist
United Technologies
Hartford, Connecticut 06101

RE: Sheller-Globe, 3200 Main St., Keokuk, Iowa

Dear Mr. Yeich:

We have had an opportunity to review the Phase III site assessment work plan for the above referenced site. The following comments relate to our concerns about the work plan in general and about some perceived needs with regard to Chapter 133.

(1) Chapter 133 requires monitoring wells to identify the horizontal extent of contamination at a site. Ultimately, wells will be necessary to establish the upgradient contaminant boundary.

(2) At some phase of investigation we will expect to see wells installed deeper than the proposed monitoring wells to further define the vertical extent of contamination.

After a review of the proposed activities, we would like to see the following additional investigative activities performed.

(1) A map showing the full extent of all buildings with relation to the present and proposed monitoring wells at the site.

(2) A study to determine all private and public wells within a 1/2 mile radius of the site with a resulting map indicating the locations of those wells with relation to the site.

(3) Measurement of the static water level in ALL monitoring wells.

(4) Phase III of the investigation is approved and may proceed provided that items (1), (2), and (3) immediately preceding are acknowledged and it is understood that these changes will be reflected in the investigation and subsequent Phase III results report.

We will look for submission of Phase III results by July 18, 1991. Thank you for your cooperation in this matter.

Sincerely,

Jim Thayer

Jim Thayer
Environmental Specialist
Solid Waste Section

cc: Field Office 6

APPENDIX C
BORING LOGS

BORING LOG

MW-09

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald DRILLED BY: T. Clay
SURFACE ELEVATION: 639.2 ELEVATION DATUM: MSL
GROUND WATER: @ 28.3' ATD (@15.3' 24 hrs AD)
OBSERVATIONS:

SHEET 1 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/23/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 4 1/4" I.D. HSA
	S		2 4 3 3		Firm, dark olive brown, medium to highly plastic Clay FILL with rock fragments, brick fragments, and some black fragments (charcoal?) (FILL)		635	
5	S		2 3 4 5		Becoming soft to firm		630	HNu=B.G. inside the auger
10	S		1 2 2 2		Soft to firm, yellowish-brown, highly plastic CLAY with trace of fine sand, gravel, and gray mottling (CH)		625	WC>PL
15	S		1 2 2 2		Becoming firm to stiff		620	▼ Slight odor detected HNu = 40 ppm inside the auger
20	S		3 5 3 4		Becoming very stiff		615	HNu = 170 ppm inside the auger Sampler is slightly wet
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

MW-09

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald DRILLED BY: T. Clay
SURFACE ELEVATION: 639.2 ELEVATION DATUM: MSL
GROUND WATER: @ 28.3' ATD (@15.3' 24 hrs AD)
OBSERVATIONS:

SHEET 2 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/23/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
25	S		5 8 11 11		SAME: Very stiff, yellowish-brown, highly plastic CLAY with trace of fine sand, gravel, and gray mottling (CH)			HNu = 75 ppm inside the auger
					With thin gravel seam (3")			▽
30	S		3 6 9 12				610	
					Becoming stiff		605	Cuttings are very wet HNu = 20 ppm inside the auger
35	S		3 5 7 12		With more sand			
							600	Bottom of Boring 37.0' 2" PVC monitoring well installed upon completion
40							595	
45							590	
50								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

MW-10

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald — DRILLED BY: T. Clay
SURFACE ELEVATION: 624.2 — ELEVATION DATUM: MSL
GROUND WATER: @ 2.0' 24 hrs AD
OBSERVATIONS:

SHEET 1 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/21/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 6 1/4" I.D. HSA
	S		2 2 3 4		Firm, olive green low to medium plastic, silty Clay FILL with trace to some gravel (FILL)			
					Becoming black with chemical odor		620	Some hard drilling
5	S		1 1 1 2		Becoming soft			HNu = 150 ppm inside hole; B.Z. = B.G.
								Cuttings are black
					Firm, yellowish to olive brown, medium to highly plastic CLAY with trace of fine sand and some gray mottling (CL/CH)		615	HNu = B.G. inside the split-spoon sampler
10	S		1 2 3 3					
	S		1 3 6 10		Stiff, yellowish-brown, highly plastic CLAY with trace of fine to medium sand and some gray mottling (CH)		610	
15	S		3 5 8 11					
					Becoming very stiff			
	S		5 9 11 16		Contains thin (1/4") sand seam		605	HNu = 5 ppm inside the auger 1/4" sand seam looks saturated
20	S		3 6 9 11		Contains some medium gravel			Auger cuttings are moist
					Becoming stiff			
	S		4 4 5 7		Becoming to contain trace of coarse gravel (rounded fragments, 1/2" to 3/4")			Poor recovery due to a rock fragment
					Becoming very stiff		600	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

MW-10

PROJECT NAME Sheller-Globe Facility
PROJECT LOCATION Keokuk, Iowa
LOGGED BY C. Fitzgerald DRILLED BY T. Clay
SURFACE ELEVATION 624.2 ELEVATION DATUM MSL
GROUND WATER @ 2.0' 24 hrs AD
OBSERVATIONS

SHEET 2 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/21/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
25	S		8 10 14 16		SAME: Very stiff, yellowish-brown, highly plastic CLAY with trace of fine sand, fine to coarse gravel, and some gray mottling, with thin (1/8-1/4") silt seam and sand seam (1/2-3/4") (CH)			HNu = 5-6 ppm inside augers; B.Z. = B.G.
					Becoming hard			Cuttings are very wet (mud)
	S		10 16 20 30		Dense, yellowish-brown, fine grained, Silty SAND (SM)		595	Sand is saturated
30					Hard, yellowish-brown, highly plastic CLAY with trace of fine sand and fine to medium gravel (CH)			
	S		7 17 28 32		Contains thin (1/2") sand seam			
								Bottom of Boring 32.0'
								4" PVC monitoring well installed upon completion
35							590	
							585	
40								
							580	
45								
							575	
50								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

MW-11

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald DRILLED BY: T. Clay
SURFACE ELEVATION: 627.3 ELEVATION DATUM: MSL
GROUND WATER: @ 28.5' 10 minutes AD; @ 5.4' 24 hours AD
OBSERVATIONS:

SHEET 1 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/20/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 4 1/4" I.D. HSA
					Firm, dark olive brown, medium plastic Clay FILL with rock fragments and some sand (FILL)			
	S		2 3 5 5		Firm, grayish-brown, low plastic, Silty CLAY (CL)		625	WC>PL
5	S		3 2 2 2					▼
					Becoming yellowish-brown		620	HNu = B.G. in B.Z. and inside augers
10	S		2 3 3 4		With some gray mottling			WC>PL
					Becoming medium plastic		615	
					Becoming stiff			
15	S		3 5 9 10		Stiff, yellowish-brown, highly plastic CLAY with trace of fine to medium sand and rounded gravel fragments, with some gray mottling (CH)			Sampler is wet
							610	Cuttings are moist
20	S		2 6 10 13		Becoming very stiff			HNu = B.G. in B.Z. and inside augers
							605	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

MW-11

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald DRILLED BY: T. Clay
SURFACE ELEVATION: 627.3 ELEVATION DATUM: MSL
GROUND WATER: @ 28.5' 10 minutes AD; @ 5.4' 24 hours AD
OBSERVATIONS:

SHEET 2 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/20/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
25	S		4 8 11 11		SAME: Very stiff, yellowish-brown, highly plastic CLAY with trace of fine sand and gravel and some gray mottling (CH)			
							600	HNu = B.G. inside augers
					Becoming hard			▽
30	S		5 17 21 31		Contains thin sand seam (2")			
					With abundant sand		595	Cuttings contain higher silt and sand content Cuttings are saturated
35	S		6 17 19 18		Dense, yellowish-brown, fine grained SAND with silt and trace of gravel (SM)			
					Hard, yellowish-brown, highly plastic CLAY with trace of fine sand and gravel with some gray mottling (CH)		590	Bottom of Boring 37.0' Water heard running into augers; augers left in hole overnight 2" PVC monitoring well installed upon completion on 5/21/91
40							585	
45							580	
50								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

MW-12

PROJECT NAME Sheller-Globe Facility
PROJECT LOCATION Keokuk, Iowa
LOGGED BY C. Fitzgerald DRILLED BY T. Clay
SURFACE ELEVATION 643.7 ELEVATION DATUM MSL
GROUND WATER None detected ATD (@ 7.75' 4 days AD)
OBSERVATIONS

SHEET 1 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/24/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 4-1/4" I.D. HSA
					Soft to firm, olive to dark olive brown, low plastic, silty Clay FILL with gravel, brick fragments, and trace of wood fragments (FILL)			Hard drilling
								HNu = 2 ppm
					Becoming dark brown to black		640	
5	S		1 2 4 4		Firm, yellowish-brown, highly plastic CLAY with trace of fine sand, gravel and gray mottling (CH)			
								▼
					Becoming stiff		635	
10	S		2 4 5 6					HNu = B.G.
					Becoming firm		630	
15	S		1 2 5 9					
					Becoming stiff to very stiff		625	HNu = B.G.
20	S		3 6 9 12					
					Becoming stiff		620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

MW-12

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald — DRILLED BY: T. Clay
SURFACE ELEVATION: 643.7 — ELEVATION DATUM: MSL
GROUND WATER: None detected ATD (@ 7.75' 4 days AD)
OBSERVATIONS:

SHEET 2 of 2
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/24/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
25	S		4 6 8 9		SAME: Stiff, yellowish-brown, highly plastic CLAY with trace of fine sand, gravel, and gray mottling (CH)			
								HNu = B.G. inside augers
					Becoming stiff to very stiff		615	
30	S		3 6 9 11					
					Becoming very stiff		610	Cuttings are very wet (mud)
35	S		4 7 9 9					
							605	Bottom of Boring 37.0' 2" PVC monitoring well installed upon completion
40							600	
45							595	
50								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-02

PROJECT NAME Sheller-Globe Facility
PROJECT LOCATION Keokuk, Iowa
LOGGED BY C. Fitzgerald DRILLED BY T. Clay
SURFACE ELEVATION 641.2 ELEVATION DATUM MSL
GROUND WATER None detected ATD
OBSERVATIONS

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/28/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 3-1/4" I.D. HSA
	S		7 7 9 9		Stiff, dark olive brown, medium plastic, Clay FILL with trace of rock and brick fragments (FILL)		640	
					Becoming soft			
5	S		2 2 1 1					Some hard drilling
					Becoming firm		635	HNu = 15 ppm near cuttings; B.Z. = B.G.
	S		3 3 4 3					Bottom of Boring
10								10.0' Boring backfilled with auger cuttings upon completion HNu = 50 ppm inside boring after auger removal
							630	
15							625	
20							620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-03

PROJECT NAME Sheller-Globe Facility
PROJECT LOCATION Keokuk, Iowa
LOGGED BY C. Fitzgerald DRILLED BY T. Clay
SURFACE ELEVATION 641.6 ELEVATION DATUM MSL
GROUND WATER None detected ATD
OBSERVATIONS

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/22/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 3-1/4" I.D. HSA
					Medium dense, medium to coarse gravel FILL			
	S		4 5 5 5		Stiff, dark olive brown, medium plastic, silty Clay FILL with gravel and trace of brick fragments (FILL)		640	HNU = 50 ppm inside boring; B.Z. = B.G.
5	S		5 5 4 5					HNu = 150 ppm inside sampler Hard drilling
					Becoming soft to firm, beginning to contain more fragments of brick or gravel?		635	HNu = 150 ppm inside borehole after auger removal
	S		2 2 2 3					
10							630	Bottom of Boring 10.0' Boring backfilled with auger cuttings upon completion
15							625	
20							620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-04

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald DRILLED BY: T. Clay
SURFACE ELEVATION: 641.6 ELEVATION DATUM: MSL
GROUND WATER: None detected ATD
OBSERVATIONS:

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/22/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 3-1/4" I.D. HSA
	S		3 3 3 4		Firm, dark olive brown, low to medium plastic, Clay FILL with abundant gravel, sand, and occasional pieces of rubber or foam (FILL)		640	HNu = 35 ppm inside augers
5	S		5 4 4 2		Becoming firm to stiff			HNu = 150 ppm inside augers
					Becoming dark brown to black		635	
	S		2 2 3 4		Firm, yellowish-brown, highly plastic CLAY with trace of fine sand, gravel, and some gray mottling (CH)			
10							630	Bottom of Boring 10.0' Boring backfilled with auger cuttings upon completion
15							625	
20							620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-05

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald — DRILLED BY: T. Clay
SURFACE ELEVATION: 641.5 — ELEVATION DATUM: MSL
GROUND WATER: None detected ATD
OBSERVATIONS:

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/28/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Asphalt			Boring advanced with 3-1/4" I.D. HSA
	S		4 4 4 6		Stiff, dark olive-brown, medium to highly plastic, Clay FILL with sand, gravel, and small rock and brick fragments (FILL)		640	Some hard drilling
5	S		3 4 2 3				635	
	S		2 2 3 4					HNu = 200 ppm inside augers
10					Firm, dark yellowish-brown, highly plastic CLAY with trace of sand and gray mottling (CH)		630	Bottom of Boring 10.0' Boring backfilled with auger cuttings upon completion HNu = 140 ppm inside boring after auger removal
15							625	
20							620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-06

PROJECT NAME: Sheller-Globe Facility
PROJECT LOCATION: Keokuk, Iowa
LOGGED BY: C. Fitzgerald DRILLED BY: T. Clay
SURFACE ELEVATION: 641.8 ELEVATION DATUM: MSL
GROUND WATER: None detected ATD
OBSERVATIONS:

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/28/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Concrete			Boring advanced with 3-1/4" I.D. HSA
					Very loose, fine to coarse Gravel FILL with some sand and a trace of clay (FILL)		640	
5	S		2 2 2 1					Chemical odor HNu = 300 ppm inside augers; B.Z. = B.G.
								Poor recovery because of coarse gravel
					Firm, yellowish-brown, highly plastic CLAY with trace of fine sand and gravel (CH)		635	
	S		2 2 3 5					
10								Bottom of Boring 10.0'
							630	Boring backfilled with auger cuttings upon completion
15								HNu = 100 ppm inside boring after auger removal
							625	Note: Borehole caved in (gravel) upon auger removal
20								
							620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-07

PROJECT NAME Sheller-Globe Facility
PROJECT LOCATION Keokuk, Iowa
LOGGED BY C. Fitzgerald DRILLED BY T. Clay
SURFACE ELEVATION 641.6 ELEVATION DATUM MSL
GROUND WATER None detected ATD
OBSERVATIONS

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/23/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Concrete			Boring advanced with 3-1/4" I.D. HSA
	S		5 7 6 6		Stiff, dark olive brown to dark brown, low plastic, silty Clay FILL with sand, gravel, brick fragments, and trace of glass (FILL)		640	
					Becoming dark brown			
5	S		2 2 2 2		Becoming soft to firm			
					Stiff, yellowish-brown, highly plastic CLAY with trace of fine sand, gravel and some gray mottling (CH)		635	
	S		5 6 6 7					
10							630	Bottom of Boring 10.0' Boring backfilled with auger cuttings upon completion
15							625	
20							620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-08

PROJECT NAME Sheller-Globe Facility
PROJECT LOCATION Keokuk, Iowa
LOGGED BY C. Fitzgerald DRILLED BY T. Clay
SURFACE ELEVATION 640.8 ELEVATION DATUM MSL
GROUND WATER None detected ATD
OBSERVATIONS

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/23/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Concrete		640	Boring advanced with 3-1/4" I.D. HSA
	S		2 3 2 2		Firm, dark olive brown, low to medium plastic, Clay FILL with sand, gravel, brick fragments and wood fragments (FILL)			
					Becoming dark brown to black			Very hard drilling
					Becoming very soft to soft			Broke through something hard at 4'-4.5'
5	S		2 1 1 1				635	
					Becoming stiff			
	S		2 4 5 6		Stiff, dark yellowish-brown, highly plastic CLAY with trace of fine sand, gravel, and some gray mottling (CH)			
10							630	Bottom of Boring 10.0' Boring backfilled with auger cuttings upon completion
15							625	
20							620	
25								

Woodward-Clyde Consultants

Figure No. A-

BORING LOG

WCS-09

PROJECT NAME Sheller-Globe Facility
PROJECT LOCATION Keokuk, Iowa
LOGGED BY C. Fitzgerald DRILLED BY T. Clay
SURFACE ELEVATION 641.9 ELEVATION DATUM MSL
GROUND WATER None detected ATD
OBSERVATIONS

SHEET 1 of 1
PROJECT NO. 91C7343
TASK NO. 0031
DATE 5/24/91
RIG CME-55

DEPTH, ft.	SAMPLE TYPE	SAMPLE RECOVERY	SAMPLE RESISTANCE	SAMPLE PP, KSF	DESCRIPTION	SYMBOL	ELEVATION	FIELD NOTES
0					Concrete			
	S		4 5 6 5		Fine to coarse grained gravel FILL (FILL) Becoming firm, olive brown to dark olive brown, medium plastic, silty Clay FILL with gravel, rock fragments, and trace of wood Becoming soft to very soft		640	Boring advanced with 3-1/4" I.D. HSA HNu = B.G.
5	S		1 1 1 1		Becoming stiff		635	
	S		3 4 6 8		Stiff, yellowish-brown, highly plastic CLAY with trace of sand and gravel and with gray mottling (CH)			
10							630	Bottom of Boring 10.0' Boring backfilled with auger cuttings upon completion
15							625	
20							620	
25								

Woodward-Clyde Consultants

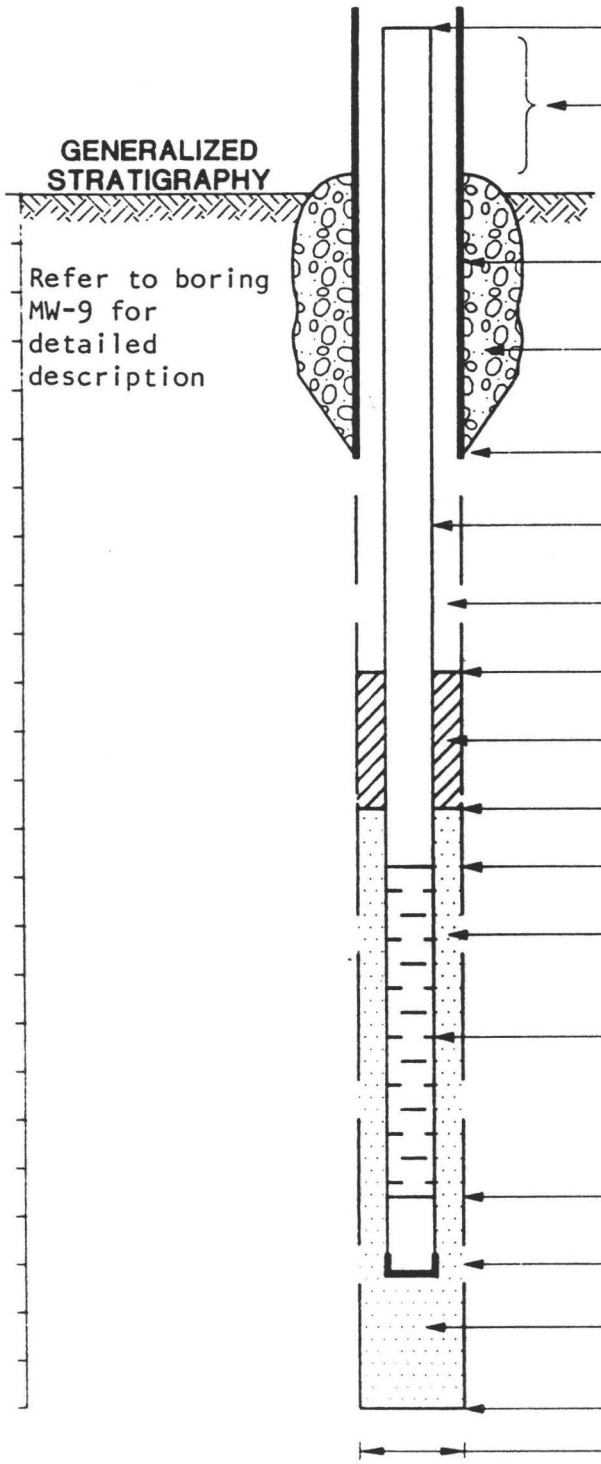
Figure No. A-

APPENDIX D
MONITORING WELL INSTALLATION REPORTS

GROUND WATER OBSERVATION WELL REPORT

Project Name Sheller-Globe Facility
Location Keokuk, Iowa
Installed by Hannibal Testing Laboratories
Inspected by Chris Fitzgerald
Method of Installation 4 1/4" ID Hollow Stem Augers
Remarks Well is flush mounted

Piez./Well No. MW-9
Project No. 91C7343
Date 5/23/91
Time 14:35



- **Elevation of top of riser pipe** 639.02'
- **Height of riser above ground** -0.18'
- **Ground Elevation** 639.20'
- **I.D./Type of surface casing** Flush mounted manhole cover
- **Type of surface seal** Sakrete concrete
- **Depth of surface seal** 1.5'
- **I.D./Type of riser pipe** 2" Sch. 40 PVC
- **Type of backfill** Volclay grout
- **Depth of top of seal** 20.5'
- **Type of seal** 1/4" Bentonite pellets
- **Depth of top of filter pack** 22.5'
- **Depth of top of screen** 24.42'
- **Type of filter pack** 20-40 Colorado Silica sand
- **I.D./Type of screen** 2" Sch. 40 PVC
- **Screen slot size** 0.010"
- **Depth of bottom of screen** 34.42'
- **Depth of bottom of plugged bank section** 35.0'
- **Type of backfill below observation well** none
- **Depth of bottom of boring** 35.0'
- **Diameter of boring** 8"

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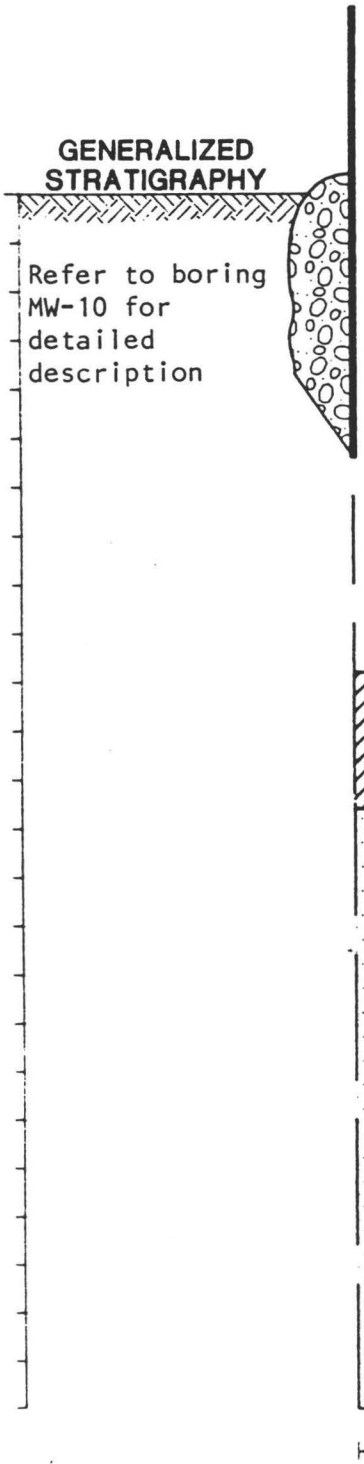
Fig. _____

GROUND WATER OBSERVATION WELL REPORT

Project Name Sheller-Globe Facility
Location Keokuk, Iowa
Installed by Hannibal Testing Laboratories
Inspected by Chris Fitzgerald
Method of Installation 6 1/4" ID (9" O.D.) Hollow Stem Augers
Remarks Well is flush mounted

Piez./Well No. MW-10
Project No. 91C7343
Date 5/21/91
Time 16:45



- **Elevation of top of riser pipe** 623.98'
- **Height of riser above ground** -0.23'
- **Ground Elevation** 624.21'
- **I.D./Type of surface casing** Flush mounted manhole cover
- **Type of surface seal** Sakrete concrete
- **Depth of surface seal** 1.5'
- **I.D./Type of riser pipe** 4" Sch. 40 PVC
- **Type of backfill** Volclay grout
- **Depth of top of seal** 15.5'
- **Type of seal** 1/4" Bentonite pellets
- **Depth of top of filter pack** 17.5'
- **Depth of top of screen** 19.42'
- **Type of filter pack** 20-40 Colorado Silica sand
- **I.D./Type of screen** 4" Sch. 40 PVC
- **Screen slot size** 0.010"
- **Depth of bottom of screen** 29.42'
- **Depth of bottom of plugged bank section** 30.0'
- **Type of backfill below observation well** none
- **Depth of bottom of boring** 30.0'
- **Diameter of boring** 9"

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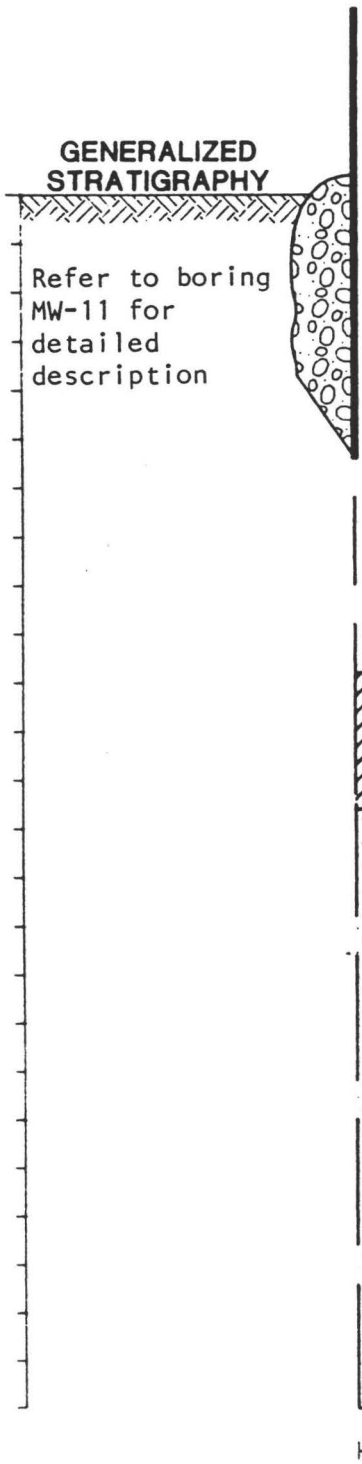
Fig. _____

GROUND WATER OBSERVATION WELL REPORT

Project Name Sheller-Globe Facility
Location Keokuk, Iowa
Installed by Hannibal Testing Laboratories
Inspected by Chris Fitzgerald
Method of Installation 4 1/4" ID Hollow Stem Augers
Remarks Well is flush mounted

Piez./Well No. MW-11
Project No. 91C7343
Date 5/21/91
Time 07:30



- **Elevation of top of riser pipe** 627.06'
- **Height of riser above ground** -0.21'
- **Ground Elevation** 627.27'
- **I.D./Type of surface casing** Flush mounted manhole cover
- **Type of surface seal** Sakrete concrete
- **Depth of surface seal** 1.5'
- **I.D./Type of riser pipe** 2" Sch. 40 PVC
- **Type of backfill** Volclay grout
- **Depth of top of seal** 20.5'
- **Type of seal** 1/4" Bentonite pellets
- **Depth of top of filter pack** 22.5'
- **Depth of top of screen** 24.42'
- **Type of filter pack** 20-40 Colorado Silica sand
- **I.D./Type of screen** 2" Sch. 40 PVC
- **Screen slot size** 0.010"
- **Depth of bottom of screen** 34.42'
- **Depth of bottom of plugged bank section** 35.0'
- **Type of backfill below observation well** none
- **Depth of bottom of boring** 35.0'
- **Diameter of boring** 8"

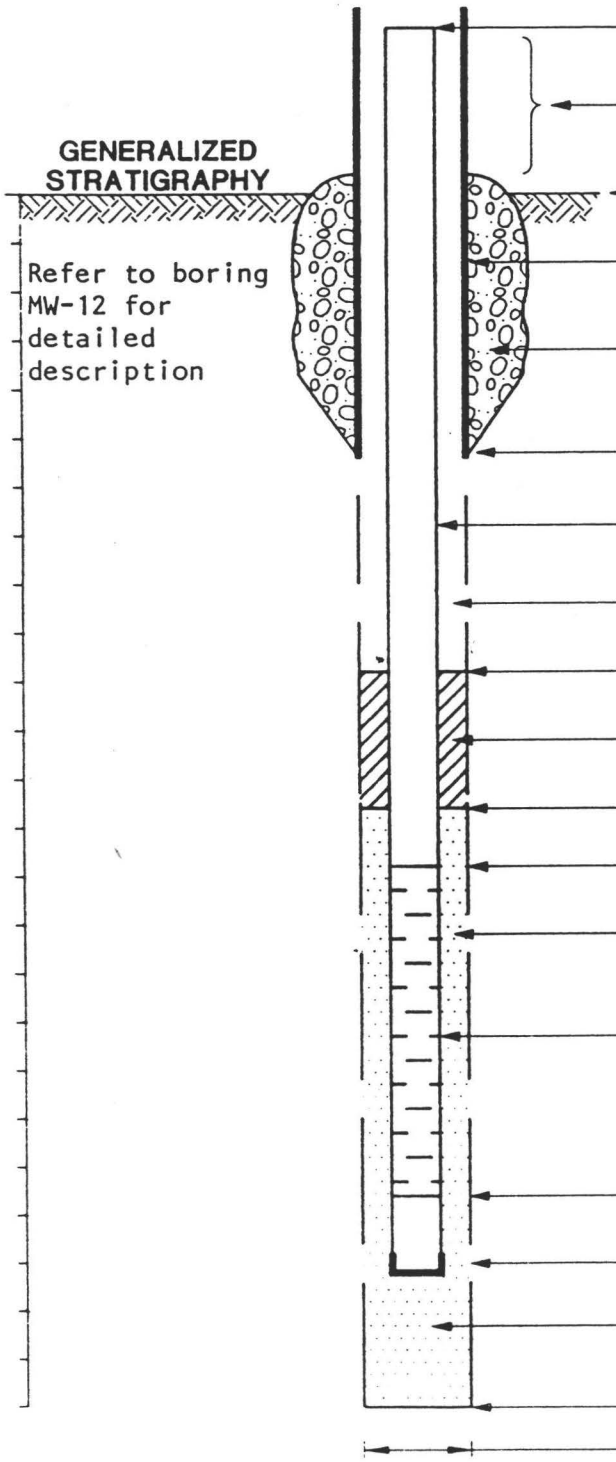
Woodward-Clyde Consultants

Fig. _____

GROUND WATER OBSERVATION WELL REPORT

Project Name: Sheller-Globe Facility
Location: Keokuk, Iowa
Installed by: Hannibal Testing Laboratories
Inspected by: Chris Fitzgerald
Method of Installation: 4 1/4" ID Hollow Stem Augers
Remarks: Well is flush mounted

Piez./Well No.: MW-12
Project No.: 91C7343
Date: 5/24/91
Time: 13:02



Elevation of top of riser pipe: 643.40'
Height of riser above ground: -0.26'
Ground Elevation: 643.66'
I.D./Type of surface casing: Flush mounted manhole cover
Type of surface seal: Sakrete concrete
Depth of surface seal: 1.5'
I.D./Type of riser pipe: 2" Sch. 40 PVC
Type of backfill: Volclay grout
Depth of top of seal: 20.5'
Type of seal: 1/4" Bentonite pellets
Depth of top of filter pack: 22.5'
Depth of top of screen: 24.42'
Type of filter pack: 20-40 Colorado Silica sand
I.D./Type of screen: 2" Sch. 40 PVC
Screen slot size: 0.010"
Depth of bottom of screen: 34.42'
Depth of bottom of plugged bank section: 35.0'
Type of backfill below observation well: none
Depth of bottom of boring: 35.0'
Diameter of boring: 8"

Woodward-Clyde Consultants

Fig. ____

APPENDIX E
SAMPLE COLLECTION FIELD SHEETS

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-1 PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION EAST SIDE OF EXCAVATION

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER: _____

WATER LEVEL: 636.09

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 4' 10 1/4" (4.85')

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 09:50 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3x40 mL VOA VIALS	HCL/4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 19.0 DATE 5-31-91

SAMPLE pH 6.7 TIME 09:50

SALINITY, PARTS PER THOU 1.0 ‰ APPEARANCE SLIGHTLY CLOUDY - YELLOWISH

CONDUCTIVITY, umhos/cm 1900 ODOR SLIGHT CHEMICAL ODOR

pH BUFFER BEFORE 7.0/4.1 pH BUFFER AFTER 7.1/4.1

COMMENTS _____

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 4"

WATER LEVEL BEFORE 4.94 WELL DEPTH (SOUNDED) 14.21

WATER LEVEL AFTER DRY TIME STARTED 13:45

EST. VOLUME REMOVED 7 GALLONS TIME COMPLETED 15:19

HNu/OVA, BACKGROUND 0.1 ppm METHOD 3" x 5' PVC BAILER

HNu/OVA, WELL HEAD 10 ppm HNu/OVA, BREATHING ZONE B.G.

COMMENTS Well CAP IS melted and IS LOOSE fitting.

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-2 PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION SOUTH OF EXCAVATION

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER: _____

WATER LEVEL: 632.90

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 7' 4½" (7.38)

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 10:10 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3x40 ml VOA vials	HCL/4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 18.0 DATE 5-31-91

SAMPLE pH 6.6 TIME 10:10

SALINITY, PARTS PER THOU 0.6 APPEARANCE CLEAR

CONDUCTIVITY, umhos/cm 825 ODOR CHEMICAL ODOR

pH BUFFER BEFORE 7.0/4.1 pH BUFFER AFTER 7.1/4.2

COMMENTS _____

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 4"

WATER LEVEL BEFORE 6.63 WELL DEPTH (SOUNDED) 12.75

WATER LEVEL AFTER DRY TIME STARTED 13:45

EST. VOLUME REMOVED 5 gallons TIME COMPLETED 15:07

HNu/OVA, BACKGROUND 0.1 ppm METHOD 3" x 5' PVC BAILER

HNu/OVA, WELL HEAD 8ppm HNu/OVA, BREATHING ZONE B6

COMMENTS well cap is melted and is loose fitting ~~(CF)~~ into the well?

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-3 PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER:

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER:

WATER LEVEL: 625.92

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 13'/1/4" (13.10)

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 09:40 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3x 40 ml VOA Vials	HCL/4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 16.0 DATE 5-31-91

SAMPLE pH 6.6 TIME 09:40

SALINITY, PARTS PER THOU 0.3 APPEARANCE none

CONDUCTIVITY, umhos/cm 800 ODOR GRAY - SLIGHTLY CLOUDY

pH BUFFER BEFORE 7.0/4.1 pH BUFFER AFTER 7.1/4.1

COMMENTS

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 4"

WATER LEVEL BEFORE 11.29 WELL DEPTH (SOUNDED) 16.77

WATER LEVEL AFTER DRY TIME STARTED 15.07

EST. VOLUME REMOVED 4.0 GALLONS TIME COMPLETED 15:33

HNu/OVA, BACKGROUND BG 0.1PPM METHOD 3" x 5' PVC BAILER

HNu/OVA, WELL HEAD BG HNu/OVA, BREATHING ZONE BG

COMMENTS LOCK IS NOT PRESENT, WELL CAP IS BROKEN. NO MANHOLE COVER

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343
SAMPLE NUMBER: MW-4 PERSONNEL: CHRIS FITZGERALD
LOCATION DESCRIPTION EAST OF EXCAVATION (EAST OF MW-1)
SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____
SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER: _____
WATER LEVEL: 636.11
WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 4' 10" (4.83)
COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 10:15 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3x 40 ML VOA vials	HCL/4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 20.0
SAMPLE pH 6.2
SALINITY, PARTS PER THOU 0
CONDUCTIVITY, umhos/cm 300
pH BUFFER BEFORE 7.0/4.1
DATE 5-31-91
TIME 10:15
APPEARANCE SLIGHTLY CLOUDY
ODOR VERY SLIGHT CHEMICAL
pH BUFFER AFTER 7.1/4.1
COMMENTS _____

DEVELOPMENT/PURGING

DATE 5-30-91
WATER LEVEL BEFORE 4.40
WATER LEVEL AFTER DRY
EST. VOLUME REMOVED 6 gallons
HNu/OVA, BACKGROUND 0.1 ppm
HNu/OVA, WELL HEAD B6
CASING DIAMETER 4"
WELL DEPTH (SOUNDED) 11.92
TIME STARTED 14:40
TIME COMPLETED 15:07
METHOD 3" x 5' PVC BAILER
HNu/OVA, BREATHING ZONE B6
COMMENTS Well cap is loose fitting.

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-6A PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION EAST OF EXCAVATION near entrance gate.

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER: _____

WATER LEVEL: 629.25

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 11' 10½" (11.88)

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 10:30 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3 x 40 ML VOA VIALS	HCL/4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 19.0 DATE 5-31-91

SAMPLE pH 7.1 TIME 10:30

SALINITY, PARTS PER THOU 1.1 APPEARANCE Clear

CONDUCTIVITY, umhos/cm 2350 ODOR Slight chemical odor

pH BUFFER BEFORE 7.1 / 4.2 pH BUFFER AFTER 7.1 / 4.1

COMMENTS _____

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 2"

WATER LEVEL BEFORE 5.58 WELL DEPTH (SOUNDED) 13.94

WATER LEVEL AFTER DRY TIME STARTED 15:30

EST. VOLUME REMOVED 5.0 gallons TIME COMPLETED 15:55

HNu/OVA, BACKGROUND 0.1 ppm METHOD Disposable PVC BAILER

HNu/OVA, WELL HEAD 2 ppm HNu/OVA, BREATHING ZONE B6

COMMENTS Chemical odor while bailing

No lock on well cap

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-6B PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION EAST OF EXCAVATION near ENTRANCE GATE

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER: _____

WATER LEVEL: 631.10

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 9' 10 3/4" (9.90)

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 10:40 METHOD: _____

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3 x 40 mL VOA vials	HCL/4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 18.5 DATE 5-31-91

SAMPLE pH 6.4 TIME 10:40

SALINITY, PARTS PER THOU 2.5 APPEARANCE clear

CONDUCTIVITY, umhos/cm 4050 ODOR none

pH BUFFER BEFORE 7.1/4.1 pH BUFFER AFTER 7.1/4.1

COMMENTS _____

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 2"

WATER LEVEL BEFORE 6.75 WELL DEPTH (SOUNDED) 31.75

WATER LEVEL AFTER DRY TIME STARTED 15:55

EST. VOLUME REMOVED 11 gallons TIME COMPLETED 16:24

HNu/OVA, BACKGROUND 0.1 ppm METHOD Disposable Bailer

HNu/OVA, WELL HEAD B6 HNu/OVA, BREATHING ZONE _____

COMMENTS Slight chemical odor while bailing. No lock on well cap

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-9 PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION near MW-3 BEHIND HAZ WASTE BUILDING

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER: _____

WATER LEVEL: 624.94

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 14'1" 14.08

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 09:10 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3 x 40 ML VOA	HCL / 4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 16.0 DATE 5-31-91

SAMPLE pH 6.9 TIME 09:10

SALINITY, PARTS PER THOU 1.0 APPEARANCE Slightly cloudy

CONDUCTIVITY, umhos/cm 1800 ODOR none

pH BUFFER BEFORE 7.0 / 4.1 pH BUFFER AFTER 7.1 / 4.1

COMMENTS Duplicate Sample called MW-14 collected from MW-9

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 2"

WATER LEVEL BEFORE 14.27 WELL DEPTH (SOUNDED) 33.58

WATER LEVEL AFTER DRY TIME STARTED 14:17

EST. VOLUME REMOVED 7 gallons TIME COMPLETED 14:47

HNu/OVA, BACKGROUND 0.1 ppm METHOD DISPOSABLE BAILER

HNu/OVA, WELL HEAD B6 HNu/OVA, BREATHING ZONE B6

COMMENTS _____

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-10 PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION Parking Lot

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____

SAMPLE SPLIT (circle one): YES (NO): SPLIT SAMPLE NUMBER: _____

WATER LEVEL: 623.36

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 7½" btoc (0.625)

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 7:40 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3 x 40 ML VIAL	HCL / 4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 22.5°C DATE 5-31-91

SAMPLE pH 6.7 TIME 07:40

SALINITY, PARTS PER THOU 0.75 APPEARANCE clear

CONDUCTIVITY, umhos/cm 1500 ODOR none

pH BUFFER BEFORE 7.2 / 4.3 pH BUFFER AFTER 7.1 / 4.4

COMMENTS _____

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 4"

WATER LEVEL BEFORE 0.875' WELL DEPTH (SOUNDED) 29.69

WATER LEVEL AFTER DRY TIME STARTED 10:44

EST. VOLUME REMOVED 29 gallons TIME COMPLETED 11:18

HNu/OVA, BACKGROUND 0.1 METHOD 3" x 5' PVC BAILER

HNu/OVA, WELL HEAD 86 HNu/OVA, BREATHING ZONE B6

COMMENTS _____

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-11 PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION PARKING LOT

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER: _____

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER: _____

WATER LEVEL: 622.52

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 4'6 1/2" (4.54)

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 7:59 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3 x 40 ML VOA VIAL	HCL / 4°C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 20.0 DATE 5-31-91

SAMPLE pH 6.9 TIME 7:59

SALINITY, PARTS PER THOU 0.2 APPEARANCE clear

CONDUCTIVITY, umhos/cm 1150 ODOR none

pH BUFFER BEFORE 7.2/4.3 pH BUFFER AFTER 7.2/4.3

COMMENTS _____

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 2"

WATER LEVEL BEFORE 4'7" = (4.58) WELL DEPTH (SOUNDED) 34.31

WATER LEVEL AFTER DRY TIME STARTED 10:05

EST. VOLUME REMOVED 18 gallons TIME COMPLETED 11:18

HNu/OVA, BACKGROUND 0.1 METHOD DISPOSABLE BAILER

HNu/OVA, WELL HEAD B6 HNu/OVA, BREATHING ZONE B6

COMMENTS _____

WOODWARD-CLYDE CONSULTANTS
5055 Antioch Road
Overland Park, Kansas 66203
(913) 432-4242

SAMPLE COLLECTION FIELD SHEET - WATER SAMPLES

PROJECT NAME: SHELLER-GLOBE FACILITY PROJECT NUMBER: 91C7343

SAMPLE NUMBER: MW-12 PERSONNEL: CHRIS FITZGERALD

LOCATION DESCRIPTION UPGRADIENT near BUILDING.

SAMPLE MEDIA (circle one): (GROUNDWATER) SURFACEWATER OTHER:

SAMPLE SPLIT (circle one): YES (NO) SPLIT SAMPLE NUMBER:

WATER LEVEL: 636.30

WATER LEVEL MEASUREMENT FROM TOP OF RISER PIPE: 7' 1 1/4" (7.10)

COLLECTION: YR: 91 MO: 05 DAY: 31 TIME: 08:20 METHOD: BAILER

SAMPLE CONTAINER	PRESERVATIVE	ANALYSIS REQUESTED
3 x 40 ML VOA VIAL.	HCL / 4° C	VOA (8240)

FIELD ANALYSIS

TEMPERATURE, °C 20.0 DATE 5-31-91

SAMPLE pH 6.9 TIME 08:20

SALINITY, PARTS PER THOU 0.5 APPEARANCE CLEAR

CONDUCTIVITY, umhos/cm 1400 ODOR none

pH BUFFER BEFORE 7.2/4.2 pH BUFFER AFTER 7.2/4.3

COMMENTS

DEVELOPMENT/PURGING

DATE 5-30-91 CASING DIAMETER 2"

WATER LEVEL BEFORE 7.10 ~~7.10~~ ~~7.7~~ (E) WELL DEPTH (SOUNDED) 34.74

WATER LEVEL AFTER DRY TIME STARTED 16:34

EST. VOLUME REMOVED ~~8~~ 10 gallons TIME COMPLETED 17:10

HNu/OVA, BACKGROUND 0.1 ppm METHOD DISPOSABLE BAILER

HNu/OVA, WELL HEAD B6 HNu/OVA, BREATHING ZONE B6

COMMENTS

APPENDIX F
SLUG TEST DATA SHEETS AND CALCULATIONS

SLUG TEST DATA SHEET

DATE: 5/31/91 PERSONNEL: Chris Fitzgerald
Tim Smith
WEATHER: Sunny 90°F
WELL DESIGNATION: MW-9 PROJECT NO. 91C7343

MEAUSUREMENT REFERENCE POINT = TOP OF 2" PVC CASING (NORTH SIDE)
MEASURED WELL INSIDE DIAMETER = 2" PVC
INITIAL DEPTH TO WATER = 14.52 FEET

TOTAL DEPTH OF WELL (BELOW MEASUREMENT REFERENCE POINT) = 33.58

SLUG: ____ LARGE (IN. DIA.) NO. OF SECTIONS = ____
LENGTH = ____ FEET
X SMALL (1¼ IN. DIA.) NO. OF SECTIONS = 1
LENGTH = 8' 3/8" FEET

WELL INFORMATION:
ELEVATION TOP OF CASING 639.02
DIAMETER OF DRILLED BOREHOLE 9"
LENGTH OF SCREEN 10 FEET
DISTANCE FROM TOP OF CASING TO TOP OF SCREEN 24.42
DISTANCE FROM TOP OF CASING TO BOTTOM OF SCREEN 34.42
DISTANCE FROM WATER LEVEL TO BOTTOM OF SCREEN 19.9 FEET

SATURATED THICKNESS OF AQUIFER ____

DEPTH OF TRANSDUCER (FROM REFERENCE POINT) = 28.0 FEET
TRANSDUCER SERIAL NUMBER 766
DEPTH OF TOP OF SLUG = 16.0 FEET (= ROPE LENGTH) (COMPARE TO INITIAL DEPTH TO WATER)
DEPTH OF BOTTOM OF SLUG = 24' 3/8" FEET (COMPARE TO TRANSDUCER)

HERMIT TEST NUMBER = 0, 1 (Ø TO 9) 0 = FALLING HEAD
X SET TEST NUMBER 1 = RISING HEAD
X SET REFERENCE DEPTH (= INITIAL DEPTH TO WATER)
X PRE-RUN CHECKOUT VALUE (PRESS XD) = ____

SLUG INSERTION:
TIME OF DAY OF START OF TEST = 13:38
TIME OF DAY OF END OF TEST = 15:35
DEPTH TO WATER AT END OF TEST (MEASURED) = 14.02 FEET

SLUG REMOVAL:
DEPTH TO WATER AT START OF TEST = 14:02 FEET
TIME OF DAY AT START OF TEST = 16.02 FEET
TIME OF DAY AT END OF TEST = 17.42 FEET

PRINTER DUMP OF TEST RESULTS ____ STEP #Ø
____ STEP #1

X FIELD REVIEW OF TEST RESULTS

COMMENTS:

SLUG TEST DATA SHEET

DATE: 5/31/91 PERSONNEL: CHRIS FITZGERALD, TIM SMITH

WEATHER: SUNNY 85°F

WELL DESIGNATION: MW-10 PROJECT NO. 91C7343

MEASUREMENT REFERENCE POINT = TOP 4" PVC CASING (NORTH SIDE)

MEASURED WELL INSIDE DIAMETER = 4" PVC

INITIAL DEPTH TO WATER = 0.54 FEET FEET

TOTAL DEPTH OF WELL (BELOW MEASUREMENT REFERENCE POINT) = 29.69

SLUG: X LARGE (IN. DIA.) NO. OF SECTIONS = _____

LENGTH = _____ FEET

___ SMALL (3" IN. DIA.) NO. OF SECTIONS = 1

LENGTH = 5.0 FEET

WELL INFORMATION:

ELEVATION TOP OF CASING 623.98

DIAMETER OF DRILLED BOREHOLE 9 INCHES

LENGTH OF SCREEN 10 FEET

DISTANCE FROM TOP OF CASING TO TOP OF SCREEN 19.19 FEET

DISTANCE FROM TOP OF CASING TO BOTTOM OF SCREEN 29.19 FEET

DISTANCE FROM WATER LEVEL TO BOTTOM OF SCREEN 28.65 FEET

SATURATED THICKNESS OF AQUIFER 28.65 FEET

DEPTH OF TRANSDUCER (FROM REFERENCE POINT) = ~~28.0~~ (CJF) 20.0 FEET

TRANSDUCER SERIAL NUMBER 2151

DEPTH OF TOP OF SLUG = 4.0 FEET (= ROPE LENGTH) (COMPARE TO INITIAL DEPTH TO WATER)

DEPTH OF BOTTOM OF SLUG = 9.0 FEET (COMPARE TO TRANSDUCER)

HERMIT TEST NUMBER = 2 (0 TO 9)

X SET TEST NUMBER

X SET REFERENCE DEPTH (= INITIAL DEPTH TO WATER)

X PRE-RUN CHECKOUT VALUE (PRESS XD) = _____

SLUG INSERTION:

TIME OF DAY OF START OF TEST = * SEE COMMENTS BELOW

TIME OF DAY OF END OF TEST = _____

DEPTH TO WATER AT END OF TEST (MEASURED) = _____ FEET

SLUG REMOVAL:

DEPTH TO WATER AT START OF TEST = 0.54 (REF = 0.54) FEET

TIME OF DAY AT START OF TEST = 18:04 FEET

TIME OF DAY AT END OF TEST = 22:00 FEET

PRINTER DUMP OF TEST RESULTS X STEP #0

___ STEP #1

X FIELD REVIEW OF TEST RESULTS

COMMENTS: THE WATER LEVEL IN THE WELL WAS 0.54 FEET BTOC PRIOR TO SLUG TESTING. BECAUSE THE WATER LEVEL WAS SO HIGH, THE INSERTION OF THE SLUG DURING THE FALLING HEAD TEST WOULD HAVE CAUSED THE WATER TO FLOW OUT OF THE TOP OF THE WELL. FOR THIS REASON ONLY THE RISING HEAD TEST WAS PERFORMED.

BY CJF DATE 6-4-91 PROJECT NAME SHELLER-GLOBE FACILITY PROJECT NUMBER 91C7243

CHKD. BY RGP DATE 06.20.91 SUBJECT SLUG TEST CALCULATIONS SHEET NO. 1 OF 7

QA/QC HAND CALCULATIONS

MW-9 (FALLING HEAD SLUG TEST)

SLUG DIMENSIONS: $\ell = 8.03$ FT

$r = 0.625$ INCHES $= 0.052$ FT

$V = \pi r^2 \ell$

$V = \pi (0.052^2)(8.03)$

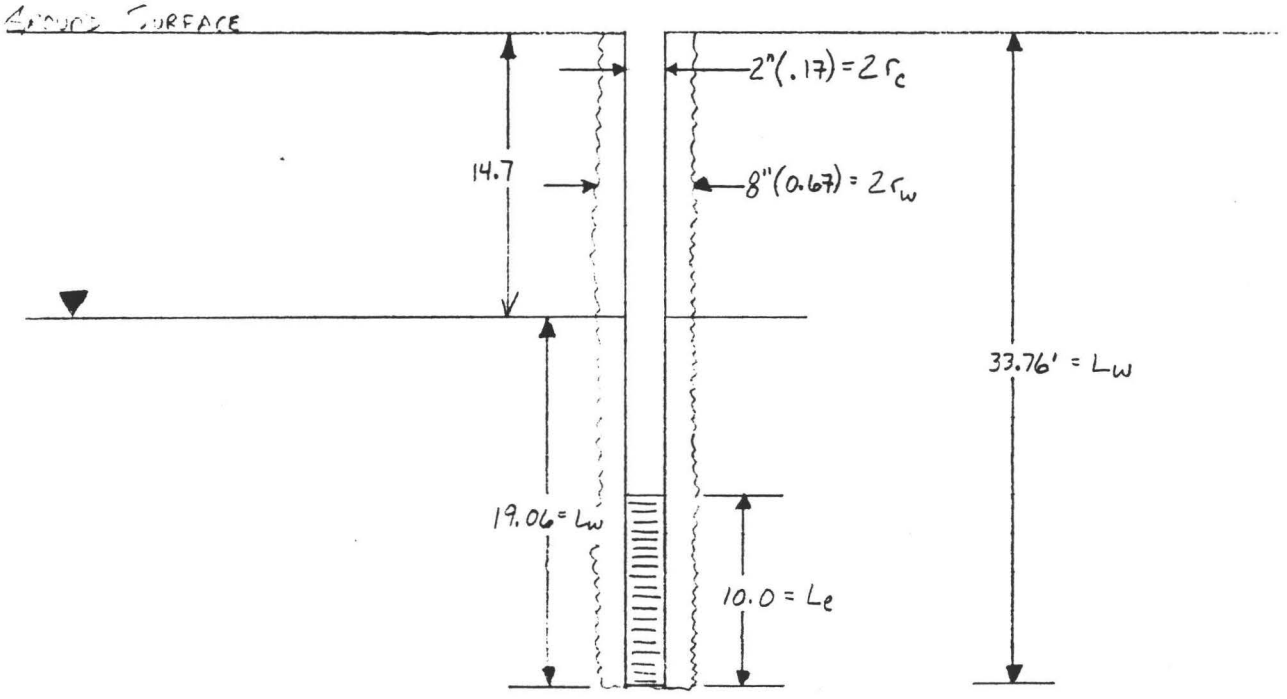
$V = 0.068$ FT^3

INITIAL DISPLACEMENT IN A WELL WITH 1 inch RADIUS:

$$0.068 \text{ FT}^3 = \pi \left(\tfrac{1}{12} \text{ FT}\right)^2 h$$

$$h = \frac{0.068 \text{ FT}^3}{\pi \left(\tfrac{1}{12} \text{ FT}\right)^2}$$

$h = 3.12$ FT = THEORETICAL INITIAL DISPLACEMENT



BY CJF DATE 6-4-91 PROJECT NAME Sheller-Globe PROJECT NUMBER 91C7343

CHKD. BY RGP DATE 06.20.91 SUBJECT Slug Test Calculations SHEET NO. 2 OF 7

Using the Bouwer and Rice (1976) and Bouwer (1989) slug test calculations

$$\text{HYDRAULIC CONDUCTIVITY} = \frac{r_c^2 \ln(Re/r_w)}{2L_e} \frac{1}{t} \ln \frac{y_0}{y_t}$$

and

$$\ln(Re/r_w) = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{C}{L_e/r_w} \right]^{-1}$$

FOR MW-9: (FALLING HEAD TEST)

r_c = 1 inch = 0.083 ft

r_w = 4 inches = 0.33 ft

L_e = 10.0 ft

L_w = 19.06 ft

* ASSUME THAT THE AQUIFER THICKNESS IS 19.06 FEET ($L_w = H$)

$\frac{L_e}{r_w} = \frac{10.0}{0.33} = 30.3$, THEREFORE FROM THE GRAPH, $C = 2.0$
(PAGE 305, VOL. 27, NO. 3, GROUNDWATER - MAY - JUNE 1989)

$$\ln(Re/r_w) = \left[\frac{1.1}{\ln(19.06/0.33)} + \frac{2.0}{10.0/0.33} \right]^{-1}$$

$$\ln(Re/r_w) = \left[\frac{1.1}{\ln 57.76} + 0.06 \right]^{-1}$$

$$\ln(Re/r_w) = \left[0.331 \right]^{-1}$$

$$\ln(Re/r_w) = 3.02$$

$$K = \frac{(0.083^2)(3.02)}{2(10)} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

$$K = (0.00104) \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

$Y_o = 2.71$

At $t = 100$ seconds, $Y_t = 2.51$ (Taken from Field Test Data MW-9)

$$K = (0.00104) \frac{1}{100} \ln \frac{2.71}{2.51}$$

$$K = (0.00104)\ 0.01\ \ln 1.08$$

$$K = 8.00 \times 10^{-7} \text{ FT/SEC} = 2.44 \times 10^{-5} \text{ CM/SEC}$$

At $t = 3000$ seconds, $Y_t = 0.470$

$$K = (0.00104)\ 1/3000 \ln \frac{2.71}{0.47}$$

$$K = (0.00104)\ (3.3 \times 10^{-4})(\ln 5.76)$$

$$K = (0.00104)(3.3 \times 10^{-4})(1.75)$$

$$K = 6.0 \times 10^{-7} \text{ FT/SEC} = 1.83 \times 10^{-5} \text{ CM/SEC}$$

At $t = 7200$ seconds, $Y_t = 0.13$

$$K = (0.00104)\ 1/7200 \ln \frac{2.71}{0.13}$$

$$K = (0.00104)(0.00014)(\ln 20.8)$$

$$K = 4.4 \times 10^{-7} \text{ FT/SEC} = 1.34 \times 10^{-5} \text{ CM/SEC}$$

AVERAGE $K = \frac{(2.44 \times 10^{-5}) + (1.83 \times 10^{-5}) + (1.34 \times 10^{-5})}{3}$

AVERAGE $K = 1.87 \times 10^{-5}$ CM/SEC (MW-9 - FALLING HEAD)

BY CJF DATE 6-5-91 PROJECT NAME SHELLER - GLOBE PROJECT NUMBER 91C7343

CHKD. BY RGP DATE 06.20.91 SUBJECT Slug Test Calculations SHEET NO. 4 OF 7

MW-9 (RISING HEAD TEST)

r_c = 1 inch = 0.083 FT

r_w = 4 inches = 0.33 FT

L_e = 10.0 FEET

L_w = 19.56 FEET

* NOTE THAT THE AQUIFER THICKNESS IS 19.56 FEET ($L_w = H$)

$$\ln(Re/r_w) = \left[\frac{1.1}{\ln \frac{(19.56)}{(0.33)}} + \frac{2.0}{\frac{10.0}{0.33}} \right]^{-1}$$

$$\ln(Re/r_w) = \left[\frac{1.1}{4.08} + 0.066 \right]^{-1}$$

$$\ln(Re/r_w) = 2.97$$

$$K = \frac{r_c^2 \ln(Re/r_w)}{2L_e} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

$$K = \frac{(0.083^2)(2.97)}{20} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

$$K = (0.00102) \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

Y_o = 2.85

at t = 12.0 SECONDS, Y_t = 2.70

$$K = (0.00102) \frac{1}{12} \ln \frac{2.85}{2.70}$$

$$K = (0.00102)(0.083)(0.0541)$$

$$K = 4.58 \times 10^{-6} \text{ FT/SEC} = 1.4 \times 10^{-4} \text{ CM/SEC}$$

at $t = 1200$ seconds, $Y_t = 1.3$

$$K = (0.00102)\left(\tfrac{1}{120}\right) \ln \frac{2.85}{1.3}$$

$$K = (0.00102)(8.3 \times 10^{-4})(0.78)$$

$$K = 6.6 \times 10^{-7} \text{ FT/SEC} = 2.0 \times 10^{-5} \text{ CM/SEC}$$

at $t = 5680$ seconds, $Y_t = 0.15$

$$K = (0.00102)\left(\tfrac{1}{5880}\right)\left(\ln \frac{2.85}{0.15}\right)$$

$$K = (0.00102)(1.7 \times 10^{-4})(2.94)$$

$$K = 5.1 \times 10^{-7} \text{ FT/SEC} = 1.55 \times 10^{-5} \text{ CM/SEC}$$

$$\text{AVERAGE } K = \frac{(1.4 \times 10^{-4}) + (2.0 \times 10^{-5}) + (1.55 \times 10^{-5})}{3}$$

AVERAGE $K = 5.58 \times 10^{-5}$ CM/SEC (MW-9 - RISING HEAD)

MW-10 (RISING HEAD TEST)

SLUG DIMENSIONS: $\ell = 5.0$ FEET

$r = 1.5$ inches $= 0.125$ feet

$V = \pi r^2 \ell$

$V = \pi (0.125^2)(5)$

$V = 0.245 \text{ FT}^3$

INITIAL DISPLACEMENT IN A WELL WITH 2" RADIUS:

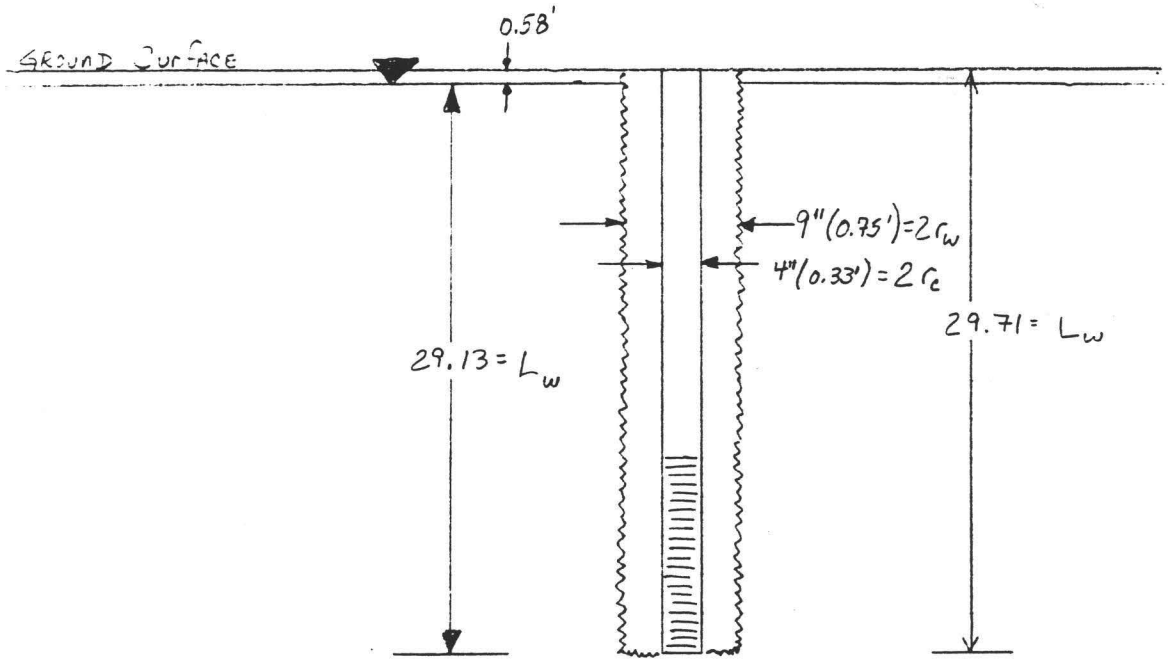
$$0.245 \text{ FT}^3 = \pi \left(\tfrac{2}{12}\right)^2 h$$

$$h = \frac{0.245}{\pi (.0278)}$$

$h = 2.8$ feet of THEORETICAL INITIAL DISPLACEMENT

BY CJF DATE 6-6-91 PROJECT NAME SHELLER - GLOBE PROJECT NUMBER 91C7343

CHKD. BY RGP DATE 06.20.91 SUBJECT SLUG TEST CALCULATIONS SHEET NO. 6 OF 7



FOR MW-10 (RISING HEAD TEST)

r_c = 2 inches = 0.16 FT

r_w = 4.5 inches = 0.375 FT

L_e = 10.0 FT

L_w = 29.13 FT

* ASSUME THAT THE AQUIFER THICKNESS IS 29.13FT ($L_w = H$)

$\frac{L_e}{r_w} = \frac{10.0}{0.375} = 26.67$, THEREFORE FROM THE GRAPH, $C = 1.9$

$$\ln(R_e/r_w) = \left[\frac{1.1}{\ln\left(\frac{29.13}{0.375}\right)} + \frac{1.9}{\frac{10.0}{0.375}}\right]^{-1}$$

$$\ln(R_e/r_w) = \underline{3.09}$$

BY CJF DATE 6-7-91 PROJECT NAME SHELLER - GLOBE PROJECT NUMBER 91C7343

CHKD. BY RGP DATE 06.20.91 SUBJECT Slug Test Calculations SHEET NO. 7 OF 7

$$K = \frac{(0.16^2)(3.09)}{2(20)} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

$$K = \frac{0.079}{20} \frac{1}{t} \ln \frac{Y_o}{Y_t}$$

$$K = (0.004) \frac{1}{t} \ln Y_o/Y_t$$

$Y_o = 2.74$

At $t = 50$ seconds, $Y_t = 2.64$

$$K = (0.004) \frac{1}{50} \ln \frac{2.74}{2.64}$$

$$K = (0.004)(0.02)(0.0372)$$

$K = 2.98 \times 10^{-6}$ FT/SEC $= 9.1 \times 10^{-5}$ CM/SEC

At $t = 3000$ seconds, $Y_t = 1.47$

$$K = (0.004) \frac{1}{3000} \ln \frac{2.74}{1.47}$$

$$K = (0.004)(0.00033)(0.623)$$

$K = 8.22 \times 10^{-7}$ FT/SEC $= 2.5 \times 10^{-5}$ CM/SEC

At $t = 13200$ seconds, $Y_t = 0.51$

$$K = (0.004)\left(\frac{1}{13,200}\right)\left(\ln \frac{2.74}{0.51}\right)$$

$$K = (0.004)(0.0000758)(1.68)$$

$K = 5.1 \times 10^{-7}$ FT/SEC $= 1.55 \times 10^{-5}$ CM/SEC

$$\text{AVERAGE } K = \frac{(9.1 \times 10^{-5}) + (2.5 \times 10^{-5}) + (1.55 \times 10^{-5})}{3}$$

AVERAGE $K = 4.38 \times 10^{-5}$ CM/SEC

PROGRAM SLUGT, VERSION 7,FEB. 1988

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3,NO.1 OF WRR ENTITLED RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER)

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS)

PROJECT NO.: 91C7343 CLIENT: UTC

SITE LOCATION: KEOKUK FACILITY DATE OF SLUG TEST: 5-31-91

FIELD INVESTIGATOR: CHRIS FITZGERALD

WELL NO.: MW-9 (FALLING HEAD TEST)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 19.06 FEET
DIAMETER OF DRILLED HOLE = 8.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 19.06 FEET
ESTIMATED POROSITY OF GRAVEL PACK = 0.15
FALLING-HEAD INDEX = 1 ("1" IF FALLING,"0" IF RISING)

NUMBER OF HEAD-TIME DATA POINTS = 92

TIME (SECONDS)	HEAD (FEET)
10.00	2.710
12.00	2.670
14.00	2.670
15.00	2.670
16.00	2.670
17.00	2.670
18.00	2.660
19.00	2.660
20.00	2.660
25.00	2.650
30.00	2.640
35.00	2.630
40.00	2.610
45.00	2.610
50.00	2.600
55.00	2.590
60.00	2.570
65.00	2.580
70.00	2.560
75.00	2.550
80.00	2.540
85.00	2.530
90.00	2.520
95.00	2.510
100.00	2.510
105.00	2.490
110.00	2.480
115.00	2.470
120.00	2.460
150.00	2.400
180.00	2.340
210.00	2.300
240.00	2.250
270.00	2.200

TIME (SECONDS)	HEAD (FEET)
300.00	2.160
330.00	2.120
360.00	2.080
390.00	2.060
420.00	2.010
450.00	1.980
480.00	1.940
510.00	1.900
540.00	1.860
570.00	1.830
600.00	1.800
720.00	1.660
840.00	1.550
960.00	1.440
1080.00	1.330
1200.00	1.250
1320.00	1.170
1440.00	1.080
1560.00	1.020
1680.00	0.950
1800.00	0.880
1920.00	0.830
2040.00	0.770
2160.00	0.730
2280.00	0.680
2400.00	0.640
2520.00	0.600
2640.00	0.560
2760.00	0.540
2880.00	0.500
3000.00	0.470
3120.00	0.460
3240.00	0.430
3360.00	0.400
3480.00	0.370
3600.00	0.360
3720.00	0.350
3840.00	0.330
3960.00	0.310
4080.00	0.280
4200.00	0.280
4320.00	0.270
4440.00	0.250
4560.00	0.240
4680.00	0.240
4800.00	0.220
4920.00	0.210
5040.00	0.210
5160.00	0.190
5280.00	0.190
5400.00	0.190
5520.00	0.170
5640.00	0.160
5760.00	0.150
5880.00	0.150
6000.00	0.150
6600.00	0.140
7200.00	0.130

H0 CALCULATED BASED ON FIRST 13 DATA POINTS

COMPUTED VALUE FOR H0 (FEET) 2.7111

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = 2.71 FEET

NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/SECOND AND PERMEABILITY UNITS ARE IN FT/SECOND

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	MINIMUM TRANS.	MAXIMUM TRANS.	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS	DIFFERENCE IN RMS
1.000E-01	1.000E-01	2.966E-06	2.966E-07	1.193E-08	7.227E-06	2.432339	3003.12	0.00
1.000E-02	1.000E-02	5.232E-06	5.232E-07	3.431E-08	9.158E-06	1.743783	1593.74	1409.38
1.000E-03	1.000E-03	8.092E-06	8.092E-07	8.814E-08	1.106E-05	1.355507	754.08	839.66
1.000E-04	1.000E-04	1.101E-05	1.101E-06	1.864E-07	1.281E-05	1.146171	332.08	422.00
1.000E-05	1.000E-05	1.372E-05	1.372E-06	3.171E-07	1.750E-05	1.252603	452.19	-120.11
1.000E-06	1.000E-06	1.636E-05	1.636E-06	4.675E-07	2.315E-05	1.386760	568.28	-116.09
1.000E-07	1.000E-07	1.914E-05	1.914E-06	6.270E-07	2.868E-05	1.465980	558.85	9.43
1.000E-08	1.000E-08	2.205E-05	2.205E-06	7.802E-07	3.412E-05	1.511879	501.03	57.82
1.000E-09	1.000E-09	2.504E-05	2.504E-06	9.643E-07	3.950E-05	1.538990	459.11	41.92
1.000E-10	1.000E-10	2.794E-05	2.794E-06	1.137E-06	4.491E-05	1.566460	486.88	-27.77

MANUAL CURVE MATCH RESULTS:

MATCH POINT AT Tt/rc**2 = 1.0, TIME = 0.0010

TRANSMISSIVITY = 7.2827E-06 FEET**2/SECOND
STORATIVITY = 1.0000E-03
METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 9.50E-07 FT/SECOND = 2.90E-05 CM/SECOND

TRANSMISSIVITY = 1.81E-05 FT**2/SECOND

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 1.33E-06 FT/SECOND = 4.05E-05 CM/SECOND

TRANSMISSIVITY = 2.54E-05 FT**2/SECOND

PROGRAM SLUGT, VERSION 7,FEB. 1988

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3,NO.1 OF WRR ENTITLED RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER)

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS)

PROJECT NO.: 91C7343 CLIENT: UTC

SITE LOCATION: KEOKUK FACILITY DATE OF SLUG TEST: 5-31-91

FIELD INVESTIGATOR: CHRIS FITZGERALD

WELL NO.: MW-9 (RISING HEAD TEST)

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES
LENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
NNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES
EPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 19.56 FEET
IAMETER OF DRILLED HOLE = 8.00 INCHES
THICKNESS OF SATURATED AQUIFER ZONE = 19.56 FEET
STIMATED POROSITY OF GRAVEL PACK = 0.15
ALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)

NUMBER OF HEAD-TIME DATA POINTS = 95

TIME (SECONDS)	HEAD (FEET)
6.00	2.840
7.00	2.790
8.00	2.720
9.00	2.700
10.00	2.710
11.00	2.710
12.00	2.700
13.00	2.690
14.00	2.680
15.00	2.680
16.00	2.680
17.00	2.670
18.00	2.670
19.00	2.670
20.00	2.660
25.00	2.650
30.00	2.630
35.00	2.620
40.00	2.610
45.00	2.600
50.00	2.590
55.00	2.580
60.00	2.570
65.00	2.560
70.00	2.550
75.00	2.540
80.00	2.530
85.00	2.520
90.00	2.510
95.00	2.500

TIME (SECONDS)	HEAD (FEET)

100.00	2.490
105.00	2.480
110.00	2.470
115.00	2.470
120.00	2.460
150.00	2.410
180.00	2.360
210.00	2.320
240.00	2.270
270.00	2.220
300.00	2.190
330.00	2.150
360.00	2.110
390.00	2.070
420.00	2.030
450.00	1.990
480.00	1.960
510.00	1.920
540.00	1.890
570.00	1.860
600.00	1.830
720.00	1.700
840.00	1.580
960.00	1.480
1080.00	1.380
1200.00	1.300
1320.00	1.210
1440.00	1.140
1560.00	1.060
1680.00	1.000
1800.00	0.940
1920.00	0.880
2040.00	0.820
2160.00	0.780
2280.00	0.730
2400.00	0.680
2520.00	0.640
2640.00	0.610
2760.00	0.570
2880.00	0.530
3000.00	0.500
3120.00	0.470
3240.00	0.450
3360.00	0.430
3480.00	0.400
3600.00	0.380
3720.00	0.350
3840.00	0.340
3960.00	0.320
4080.00	0.300
4200.00	0.290
4320.00	0.270
4440.00	0.260
4560.00	0.250
4680.00	0.240
4800.00	0.220
4920.00	0.210
5040.00	0.200
5160.00	0.200
5280.00	0.190
5400.00	0.180
5520.00	0.170
5640.00	0.160
5760.00	0.150
5880.00	0.150

H0 CALCULATED BASED ON FIRST 12 DATA POINTS

COMPUTED VALUE FOR H0 (FEET) 2.8488

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = 2.85 FEET

NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/SECOND AND PERMEABILITY UNITS ARE IN FT/SECOND

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	MINIMUM TRANS.	MAXIMUM TRANS.	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS	DIFFERENCE IN RMS
1.000E-01	1.000E-01	3.446E-06	3.446E-07	1.541E-07	7.541E-06	2.143881	2035.02	0.00
1.000E-02	1.000E-02	7.793E-06	7.793E-07	4.434E-07	1.805E-05	2.258957	319.47	1715.55
1.000E-03	1.000E-03	1.380E-05	1.380E-06	1.139E-06	4.292E-05	3.026713	608.55	-289.08
1.000E-04	1.000E-04	2.005E-05	2.005E-06	3.115E-06	7.006E-05	3.338753	953.70	-345.15
1.000E-05	1.000E-05	2.601E-05	2.601E-06	5.455E-06	9.671E-05	3.508967	1214.15	-260.45
1.000E-06	1.000E-06	3.182E-05	3.182E-06	7.825E-06	1.227E-04	3.611196	1358.49	-144.34
1.000E-07	1.000E-07	3.770E-05	3.770E-06	1.005E-05	1.485E-04	3.673371	1403.33	-44.83
1.000E-08	1.000E-08	4.367E-05	4.367E-06	1.221E-05	1.739E-04	3.702271	1400.53	2.80
1.000E-09	1.000E-09	4.969E-05	4.969E-06	1.446E-05	1.991E-04	3.715026	1386.52	14.00
1.000E-10	1.000E-10	5.562E-05	5.562E-06	1.663E-05	2.240E-04	3.727824	1392.63	-6.11

MANUAL CURVE MATCH RESULTS:

MATCH POINT AT Tt/rc**2 = 1.0, TIME = 0.0003

TRANSMISSIVITY = 1.8392E-06 FEET**2/SECOND
STORATIVITY = 1.0000E-01
METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 4.35E-06 FT/SECOND = 1.32E-04 CM/SECOND

TRANSMISSIVITY = 8.50E-05 FT**2/SECOND

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 6.08E-06 FT/SECOND = 1.85E-04 CM/SECOND

TRANSMISSIVITY = 1.19E-04 FT**2/SECOND

PROGRAM SLUGT, VERSION 7,FEB. 1988

HIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:
(1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3,NO.1 OF WRR ENTITLED RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER)

(2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED A SLUG TEST FOR DETERMINING HYDRAULIC ONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS)

PROJECT NO.: 91C7343 CLIENT: UTC

SITE LOCATION: KEOKUK FACILITY DATE OF SLUG TEST: 5-31-91

FIELD INVESTIGATOR: CHRIS FITZGERALD

WELL NO.: MW-10R

INPUT DATA ARE:

NNER CASING DIAMETER = 4.00 INCHES
ENGTH OF SCREEN OR INTAKE PORTION = 10.00 FEET
INNER SCREEN OR OPEN-HOLE DIAMETER = 4.00 INCHES
DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 29.13 FEET
IAMETER OF DRILLED HOLE = 9.00 INCHES
HICKNESS OF SATURATED AQUIFER ZONE = 29.13 FEET
STIMATED POROSITY OF GRAVEL PACK = 0.15
FALLING-HEAD INDEX = 0 ("1" IF FALLING,"0" IF RISING)

NUMBER OF HEAD-TIME DATA POINTS = 108

TIME (SECONDS)	HEAD (FEET)
6.00	2.740
7.00	2.740
8.00	2.730
9.00	2.730
10.00	2.710
11.00	2.710
12.00	2.700
13.00	2.700
14.00	2.690
15.00	2.690
16.00	2.690
17.00	2.680
18.00	2.680
19.00	2.680
20.00	2.680
25.00	2.670
30.00	2.660
35.00	2.660
40.00	2.650
45.00	2.640
50.00	2.640
55.00	2.630
60.00	2.630
65.00	2.620
70.00	2.610
75.00	2.610
80.00	2.610
85.00	2.600
90.00	2.600
95.00	2.590
100.00	2.590
105.00	2.580
110.00	2.580
115.00	2.580
120.00	2.570
150.00	2.540

180.00	2.520
210.00	2.500
240.00	2.480
270.00	2.460
300.00	2.440
330.00	2.420
360.00	2.400
390.00	2.380
420.00	2.360
450.00	2.350
480.00	2.330
510.00	2.320
540.00	2.300
570.00	2.280
600.00	2.270
720.00	2.200
840.00	2.140
960.00	2.090
1080.00	2.040
1200.00	1.990
1320.00	1.940
1440.00	1.900
1560.00	1.860
1680.00	1.820
1800.00	1.780
1920.00	1.740
2040.00	1.710
2160.00	1.680
2280.00	1.640
2400.00	1.610
2520.00	1.580
2640.00	1.550
2760.00	1.520
2880.00	1.490
3000.00	1.470
3120.00	1.440
3240.00	1.420
3360.00	1.390
3480.00	1.370
3600.00	1.350
3720.00	1.320
3840.00	1.300
3960.00	1.280
4080.00	1.260
4200.00	1.240
4320.00	1.220
4440.00	1.200
4560.00	1.180
4680.00	1.160
4800.00	1.140
4920.00	1.130
5040.00	1.110
5160.00	1.090
5280.00	1.080
5400.00	1.060
5520.00	1.040
5640.00	1.030
5760.00	1.010
5880.00	1.000
6000.00	0.980
6600.00	0.920
7200.00	0.860
7800.00	0.810
8400.00	0.760
9000.00	0.720
9600.00	0.680
10200.00	0.650
10800.00	0.610
11400.00	0.590
12000.00	0.560
12600.00	0.530

13200.00 0.510

H0 CALCULATED BASED ON FIRST 18 DATA POINTS

COMPUTED VALUE FOR H0 (FEET) 2.7434

METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS

COMPUTED RESULTS:

COMPUTED VALUE OF H0 = 2.74 FEET

NOTE: TRANSMISSIVITY UNITS ARE IN FT**2/SECOND AND PERMEABILITY UNITS ARE IN FT/SECOND

ALPHA	STORATIVITY	MEAN TRANSMIS-SIVITY	MEAN PERMEA-BILITY	MINIMUM TRANS.	MAXIMUM TRANS.	RATIO OF "T" RANGE TO TBAR	ROOT MEAN SQUARE OF TIME DEVIATIONS	DIFFERENCE IN RMS
1.000E-01	1.000E-01	2.537E-06	2.537E-07	2.151E-07	4.015E-06	1.497659	2053.27	0.00
1.000E-02	1.000E-02	6.935E-06	6.935E-07	6.188E-07	1.026E-05	1.390598	264.11	1789.16
1.000E-03	1.000E-03	1.389E-05	1.389E-06	1.589E-06	3.063E-05	2.091461	1376.74	-1112.63
1.000E-04	1.000E-04	2.169E-05	2.169E-06	3.362E-06	5.547E-05	2.402349	1854.31	-477.57
1.000E-05	1.000E-05	2.947E-05	2.947E-06	6.315E-06	8.037E-05	2.512588	2083.02	-228.71
1.000E-06	1.000E-06	3.711E-05	3.711E-06	9.618E-06	1.050E-04	2.569386	2211.53	-128.51
1.000E-07	1.000E-07	4.463E-05	4.463E-06	1.278E-05	1.294E-04	2.612715	2293.73	-82.20
1.000E-08	1.000E-08	5.205E-05	5.205E-06	1.592E-05	1.535E-04	2.642191	2350.03	-56.31
1.000E-09	1.000E-09	5.942E-05	5.942E-06	1.902E-05	1.772E-04	2.662777	2393.14	-43.10
1.000E-10	1.000E-10	6.670E-05	6.670E-06	2.169E-05	2.009E-04	2.687405	2443.65	-50.52

MANUAL CURVE MATCH RESULTS:

MATCH POINT AT Tt/rc**2 = 1.0, TIME = 0.0003

TRANSMISSIVITY = 7.3569E-06 FEET**2/SECOND
STORATIVITY = 1.0000E-02

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY = 4.66E-06 FT/SECOND = 1.42E-04 CM/SECOND

TRANSMISSIVITY = 1.36E-04 FT**2/SECOND

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY = 5.75E-06 FT/SECOND = 1.75E-04 CM/SECOND

TRANSMISSIVITY = 1.67E-04 FT**2/SECOND

APPENDIX G
ENSECO ANALYTICAL REPORTS

Rocky Mountain
Analytical Laboratory

Enseco
A CORNING Company

June 6, 1991

Mr. David Dods
Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Dear Mr. Dods:

Enclosed is the report for two samples received at Enseco-Rocky Mountain Analytical Laboratory on May 23, 1991.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Julie Essey
Program Administrator

Reviewed by:

Sue Dalla
Manager
Program Administration

JE/SD/heg
Enclosures

RMAL #015095

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

Enseco

ANALYTICAL RESULTS

FOR

WOODWARD-CLYDE CONSULTANTS

ENSECO-RMAL NO. 015095

JUNE 6, 1991

Reviewed by: J A Essey
Julie Essey

Susan C Wyatt for
Sue Dalla

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

"J" values have been reported for the volatiles, semivolatiles and metals analyses. A "J" value indicates an estimated value. For Methods 8240 and 8270 a "J" value is where the mass spectra data indicate the presence of a compound which meets identification criteria; however, the result is less than the reporting limit but greater than the instrument detection limit (IDL).

All analyses at Enseco are performed so that the maximum concentration of sample consistent with the method is analyzed. Dilutions are at times required to avoid saturation of the detector, to achieve linearity for a specific target compound or to reduce matrix interferences. In this event, reporting limits are adjusted proportionately. Surrogate compounds may not be measurable in samples which have been diluted.

Sample 015095-0002 by Method 8240 was prepared as a medium level soil based on the screening data. No further dilutions were required for the final analysis. The reporting limits for sample 015095-0002 are nominal for medium level soils.

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

Enseco
A Corning Company

SAMPLE DESCRIPTION INFORMATION
for
Woodward-Clyde Consultants

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
015095-0001-SA	MW-11 (30-32')	SOIL	20 MAY 91		23 MAY 91
015095-0002-SA	MW-10 (5-7')	SOIL	21 MAY 91		23 MAY 91

Enseco
A Corning Company

ANALYTICAL TEST REQUESTS
for
Woodward-Clyde Consultants

Lab ID: 015095	Group Code	Analysis Description	Custom Test?
0001 - 0002	A	Volatile Organics	Y
		Target Compound List (TCL)	Y
		GC Screen For Low Level Soils	N
		Volatile Organics	Y
		Target Compound List (TCL)	Y
		VOA Screen for Medium Level Soils	N

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, May, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-11 (30-32')
Lab ID: 015095-0001-SA
Matrix: SOIL Sampled: 20 MAY 91 Received: 23 MAY 91
Authorized: 23 MAY 91 Prepared: 24 MAY 91 Analyzed: 28 MAY 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	19	ug/kg	10	
Benzene	ND	ug/kg	5.0	
Bromodichloromethane	ND	ug/kg	5.0	
Bromoform	ND	ug/kg	5.0	
Bromomethane	ND	ug/kg	10	
2-Butanone (MEK)	3.3	ug/kg	10	J
Carbon disulfide	ND	ug/kg	5.0	
Carbon tetrachloride	ND	ug/kg	5.0	
Chlorobenzene	ND	ug/kg	5.0	
Chloroethane	ND	ug/kg	10	
Chloroform	ND	ug/kg	5.0	
Chloromethane	ND	ug/kg	10	
Dibromochloromethane	ND	ug/kg	5.0	
1,1-Dichloroethane	ND	ug/kg	5.0	
1,2-Dichloroethane	ND	ug/kg	5.0	
1,1-Dichloroethene	ND	ug/kg	5.0	
1,2-Dichloroethene (total)	ND	ug/kg	5.0	
1,2-Dichloropropane	ND	ug/kg	5.0	
cis-1,3-Dichloropropene	ND	ug/kg	5.0	
trans-1,3-Dichloropropene	ND	ug/kg	5.0	
Ethylbenzene	ND	ug/kg	5.0	
2-Hexanone	ND	ug/kg	10	
Methylene chloride	2.5	ug/kg	5.0	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	10	
Styrene	ND	ug/kg	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/kg	5.0	
Tetrachloroethene	ND	ug/kg	5.0	
Toluene	ND	ug/kg	5.0	
1,1,1-Trichloroethane	ND	ug/kg	5.0	
1,1,2-Trichloroethane	ND	ug/kg	5.0	
Trichloroethene	ND	ug/kg	5.0	
Vinyl acetate	ND	ug/kg	10	
Vinyl chloride	ND	ug/kg	10	
Xylenes (total)	ND	ug/kg	5.0	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Cesar Rojas Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-11 (30-32')
Lab ID: 015095-0001-SA
Matrix: SOIL
Authorized: 23 MAY 91

Sampled: 20 MAY 91
Prepared: 24 MAY 91

Received: 23 MAY 91
Analyzed: 28 MAY 91

Surrogate	Recovery	
Toluene-d8	103	%
4-Bromofluorobenzene	96	%
1,2-Dichloroethane-d4	91	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Cesar Rojas

Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-10 (5-7')
Lab ID: 015095-0002-SA
Matrix: SOIL Sampled: 21 MAY 91 Received: 23 MAY 91
Authorized: 23 MAY 91 Prepared: 24 MAY 91 Analyzed: 30 MAY 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	ND	ug/kg	1000	
Benzene	ND	ug/kg	500	
Bromodichloromethane	ND	ug/kg	500	
Bromoform	ND	ug/kg	500	
Bromomethane	ND	ug/kg	1000	
2-Butanone (MEK)	ND	ug/kg	1000	
Carbon disulfide	ND	ug/kg	500	
Carbon tetrachloride	ND	ug/kg	500	
Chlorobenzene	ND	ug/kg	500	
Chloroethane	ND	ug/kg	1000	
Chloroform	ND	ug/kg	500	
Chloromethane	ND	ug/kg	1000	
Dibromochloromethane	ND	ug/kg	500	
1,1-Dichloroethane	ND	ug/kg	500	
1,2-Dichloroethane	ND	ug/kg	500	
1,1-Dichloroethene	ND	ug/kg	500	
1,2-Dichloroethene (total)	ND	ug/kg	500	
1,2-Dichloropropane	ND	ug/kg	500	
cis-1,3-Dichloropropene	ND	ug/kg	500	
trans-1,3-Dichloropropene	ND	ug/kg	500	
Ethylbenzene	1000	ug/kg	500	
2-Hexanone	ND	ug/kg	1000	
Methylene chloride	140	ug/kg	500	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	1000	
Styrene	ND	ug/kg	500	
1,1,2,2-Tetrachloroethane	ND	ug/kg	500	
Tetrachloroethene	ND	ug/kg	500	
Toluene	6200	ug/kg	500	
1,1,1-Trichloroethane	ND	ug/kg	500	
1,1,2-Trichloroethane	ND	ug/kg	500	
Trichloroethene	ND	ug/kg	500	
Vinyl acetate	ND	ug/kg	1000	
Vinyl chloride	ND	ug/kg	1000	
Xylenes (total)	2600	ug/kg	500	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	20000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Deneen Spence Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-10 (5-7')
Lab ID: 015095-0002-SA
Matrix: SOIL Sampled: 21 MAY 91 Received: 23 MAY 91
Authorized: 23 MAY 91 Prepared: 24 MAY 91 Analyzed: 30 MAY 91

Surrogate	Recovery	
Toluene-d8	97	%
4-Bromofluorobenzene	98	%
1,2-Dichloroethane-d4	102	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Deneen Spence Approved By: Mark Dymerski

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\% \text{ Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{\left| \text{Measured Concentration DCS1} - \text{Measured Concentration DCS2} \right|}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

Enseco
A Corning Company

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC/MS

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
015095-0001-SA	SOIL	8240-SL	15 MAY 91-L	28 MAY 91-L
015095-0002-SA	SOIL	8240-S	13 MAY 91-A	28 MAY 91-A

Enseco
A Corning Company

DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Precision Limit
Category: 8240-SL Matrix: SOIL QC Lot: 15 MAY 91-L Concentration Units: ug/Kg								
1,1-Dichloroethene	50	47.2	42.9	45.0	90	59-172	9.5	22
Trichloroethene	50	46.4	41.4	43.9	88	62-137	11	24
Benzene	50	49.9	46.6	48.2	97	66-142	6.8	21
Toluene	50	48.0	45.9	47.0	94	59-139	4.5	21
Chlorobenzene	50	48.8	48.1	48.4	97	60-133	1.4	21
Category: 8240-S Matrix: SOIL QC Lot: 13 MAY 91-A Concentration Units: ug/kg								
1,1-Dichloroethene	5000	4500	4120	4310	86	59-172	8.8	22
Trichloroethene	5000	5340	5170	5260	105	62-137	3.2	24
Benzene	5000	5750	5750	5750	115	66-142	0.0	21
Toluene	5000	6030	5900	5960	119	59-139	2.2	21
Chlorobenzene	5000	5870	5810	5840	117	60-133	1.0	21

Calculations are performed before rounding to avoid round-off errors in calculated results.

Enseco
A Corning Company

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 8240-SL				
Matrix: SOIL				
QC Lot: 15 MAY 91-L QC Run: 28 MAY 91-L				
Concentration Units: ug/Kg				
1,2-Dichloroethane-d4	50.0	46.4	93	70-121
4-Bromofluorobenzene	50.0	51.1	102	74-121
Toluene-d8	50.0	51.1	102	81-117
Category: 8240-S				
Matrix: SOIL				
QC Lot: 13 MAY 91-A QC Run: 28 MAY 91-A				
Concentration Units: ug/kg				
1,2-Dichloroethane-d4	5000	5370	107	70-121
4-Bromofluorobenzene	5000	5450	109	74-121
Toluene-d8	5000	5380	108	81-117

Calculations are performed before rounding to avoid round-off errors in calculated results.

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A Corning Company

METHOD BLANK REPORT
Volatile Organics by GC/MS

Test: 8240CPL-TCL-S
Matrix: SOIL
QC Lot: 15 MAY 91-L QC Run: 28 MAY 91-L

Analyte	Result	Units	Reporting Limit
Acetone	ND	ug/kg	10
Benzene	ND	ug/kg	5.0
Bromodichloromethane	ND	ug/kg	5.0
Bromoform	ND	ug/kg	5.0
Bromomethane	ND	ug/kg	10
2-Butanone (MEK)	ND	ug/kg	10
Carbon disulfide	ND	ug/kg	5.0
Carbon tetrachloride	ND	ug/kg	5.0
Chlorobenzene	ND	ug/kg	5.0
Chloroethane	ND	ug/kg	10
Chloroform	ND	ug/kg	5.0
Chloromethane	ND	ug/kg	10
Dibromochloromethane	ND	ug/kg	5.0
1,1-Dichloroethane	ND	ug/kg	5.0
1,2-Dichloroethane	ND	ug/kg	5.0
1,1-Dichloroethene	ND	ug/kg	5.0
1,2-Dichloroethene (total)	ND	ug/kg	5.0
1,2-Dichloropropane	ND	ug/kg	5.0
cis-1,3-Dichloropropene	ND	ug/kg	5.0
trans-1,3-Dichloropropene	ND	ug/kg	5.0
Ethylbenzene	ND	ug/kg	5.0
2-Hexanone	ND	ug/kg	10
Methylene chloride	6.9	ug/kg	5.0
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	10
Styrene	ND	ug/kg	5.0
1,1,2,2-Tetrachloroethane	ND	ug/kg	5.0
Tetrachloroethene	ND	ug/kg	5.0
Toluene	ND	ug/kg	5.0
1,1,1-Trichloroethane	ND	ug/kg	5.0
1,1,2-Trichloroethane	ND	ug/kg	5.0
Trichloroethene	ND	ug/kg	5.0
Vinyl acetate	ND	ug/kg	10
Vinyl chloride	ND	ug/kg	10
Xylenes (total)	ND	ug/kg	5.0
Hexane	ND	ug/kg	--
n-Butyl alcohol	ND	ug/kg	--
Isobutanol	ND	ug/kg	200

METHOD BLANK REPORT
Volatile Organics by GC/MS (cont.)

Test: 8240CPM-TCL-S
Matrix: SOIL
QC Lot: 13 MAY 91-A QC Run: 28 MAY 91-A

Analyte	Result	Units	Reporting Limit	
Acetone	390	ug/kg	1000	J
Benzene	ND	ug/kg	500	
Bromodichloromethane	ND	ug/kg	500	
Bromoform	ND	ug/kg	500	
Bromomethane	ND	ug/kg	1000	
2-Butanone (MEK)	ND	ug/kg	1000	
Carbon disulfide	ND	ug/kg	500	
Carbon tetrachloride	ND	ug/kg	500	
Chlorobenzene	ND	ug/kg	500	
Chloroethane	ND	ug/kg	1000	
Chloroform	ND	ug/kg	500	
Chloromethane	ND	ug/kg	1000	
Dibromochloromethane	ND	ug/kg	500	
1,1-Dichloroethane	ND	ug/kg	500	
1,2-Dichloroethane	ND	ug/kg	500	
1,1-Dichloroethene	ND	ug/kg	500	
1,2-Dichloroethene (total)	ND	ug/kg	500	
1,2-Dichloropropane	ND	ug/kg	500	
cis-1,3-Dichloropropene	ND	ug/kg	500	
trans-1,3-Dichloropropene	ND	ug/kg	500	
Ethylbenzene	ND	ug/kg	500	
2-Hexanone	ND	ug/kg	1000	
Methylene chloride	ND	ug/kg	500	
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	1000	
Styrene	ND	ug/kg	500	
1,1,2,2-Tetrachloroethane	ND	ug/kg	500	
Tetrachloroethene	ND	ug/kg	500	
Toluene	ND	ug/kg	500	
1,1,1-Trichloroethane	ND	ug/kg	500	
1,1,2-Trichloroethane	ND	ug/kg	500	
Trichloroethene	ND	ug/kg	500	
Vinyl acetate	ND	ug/kg	1000	
Vinyl chloride	ND	ug/kg	1000	
Xylenes (total)	ND	ug/kg	500	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	20000	

Appendix

CHAIN OF CUSTODY RECORD

WOODWARD-CLYDE CONSULTANTS • 5055 ANTIOCH ROAD • OVERLAND PARK, KANSAS 66203 • 913-432-4242

SAMPLER(S)	PROJECT NAME	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET
CHRIS FITZGERALD	SHELLER-GLOBE KEOKUK, IOWA	21 / 05 / 91	1 of 1

CONTENTS OF SHIPMENT: Rmal # 15095

SAMPLE NUMBER	TYPE OF CONTAINERS: CUBITAINER	8 OZ BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
	NUMBERS OF CONTAINERS PER SAMPLE NUMBER										
MLC-11											Please Note:
(30-32 feet)		1					X				* This sample collected
											on 5-20-91 ***
MLC-1C											
(5-7 feet)		1					X				* This sample collected
											on 5-21-91 ***
											Note: Both of
											these samples are
											to be analyzed
											for VOA (method 8240)
											plus Methyl isobutyl
											ketone, n-hexane,
											and butanol. *

DESCRIPTION OF SHIPMENT

1 PIECE(S) CONSISTING OF 1 ICE CHEST(S)

RECEIVING LABORATORY: ENSECO - RMAL

MODE OF SHIPMENT

X COMMERCIAL CARRIER: FEDERAL EXPRESS

__ COURIER

__ SAMPLER CONVEYED

0698250276 (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
Christopher Fitzgerald	5-21-91	18:00	FEDERAL EXPRESS	SHIP to LAB
☒ SEALED ☐ UNSEALED			☒ SEALED ☐ UNSEALED	
RELINQUISHED BY	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			Joe Mueo 5/23/91 0800 ☒ SEALED ☐ UNSEALED	
RELINQUISHED BY	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
☐ SEALED ☐ UNSEALED			☐ SEALED ☐ UNSEALED	

Rocky Mountain
Analytical Laboratory

4/6

Enseco
A CORNING Company

June 7, 1991

Mr. David Dods
Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Dear Mr. Dods:

Enclosed is the report for two samples received at Enseco-Rocky Mountain Analytical Laboratory on May 24, 1991.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Julie Essey
Program Administrator

Reviewed by:

Sue Dalla
Manager
Program Administration

JE/SD/dmh
Enclosures

RMAL #015127

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

Enseco

ANALYTICAL RESULTS

FOR

WOODWARD-CLYDE CONSULTANTS

ENSECO-RMAL NO. 015127

JUNE 7, 1991

Reviewed by:

Julie Essey

Sue Dalla

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

"J" values have been reported for the volatiles, semivolatiles, and metals analyses. A "J" value indicates an estimated value. For Methods 8240 and 8270 a "J" value is where the mass spectra data indicate the presence of a compound which meets identification criteria; however, the result is less than the reporting limit but greater than the instrument detection limit (IDL).

All analyses at Enseco are performed so that the maximum concentration of sample consistent with the method is analyzed. Dilutions are at times required to avoid saturation of the detector, to achieve linearity for a specific target compound, or to reduce matrix interferences. In this event, reporting limits are adjusted proportionately. Surrogate compounds may not be measurable in samples which have been diluted.

Samples 015127-0001 and -0002 by Method 8240 were prepared as medium level soils based on the screening data. Both samples were further diluted due to elevated concentrations of target compounds. The surrogates for sample 015127-0001 were not recovered and are, therefore, reported as ND (not detected).

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

Enseco
A Corning Company

SAMPLE DESCRIPTION INFORMATION
for
Woodward-Clyde Consultants

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
015127-0001-SA	WCS-3 (1.5-3.5 feet)	SOIL	22 MAY 91		24 MAY 91
015127-0002-SA	WCS-4 (8-10 feet)	SOIL	22 MAY 91		24 MAY 91

Enseco
A Corning Company

ANALYTICAL TEST REQUESTS
for
Woodward-Clyde Consultants

Lab ID: 015127	Group Code	Analysis Description	Custom Test?
0001 - 0002	A	Volatile Organics	Y
		Target Compound List (TCL)	Y
		GC Screen For Low Level Soils	N
		Volatile Organics	Y
		Target Compound List (TCL)	Y
		VOA Screen for Medium Level Soils	N

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, May, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-3 (1.5-3.5 feet)
Lab ID: 015127-0001-SA
Matrix: SOIL Sampled: 22 MAY 91 Received: 24 MAY 91
Authorized: 24 MAY 91 Prepared: 29 MAY 91 Analyzed: 01 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	ND	ug/kg	200000	
Benzene	ND	ug/kg	100000	
Bromodichloromethane	ND	ug/kg	100000	
Bromoform	ND	ug/kg	100000	
Bromomethane	ND	ug/kg	200000	
2-Butanone (MEK)	ND	ug/kg	200000	
Carbon disulfide	ND	ug/kg	100000	
Carbon tetrachloride	ND	ug/kg	100000	
Chlorobenzene	ND	ug/kg	100000	
Chloroethane	ND	ug/kg	200000	
Chloroform	ND	ug/kg	100000	
Chloromethane	ND	ug/kg	200000	
Dibromochloromethane	ND	ug/kg	100000	
1,1-Dichloroethane	ND	ug/kg	100000	
1,2-Dichloroethane	ND	ug/kg	100000	
1,1-Dichloroethene	ND	ug/kg	100000	
1,2-Dichloroethene (total)	ND	ug/kg	100000	
1,2-Dichloropropane	ND	ug/kg	100000	
cis-1,3-Dichloropropene	ND	ug/kg	100000	
trans-1,3-Dichloropropene	ND	ug/kg	100000	
Ethylbenzene	ND	ug/kg	100000	
2-Hexanone	ND	ug/kg	200000	
Methylene chloride	22000	ug/kg	100000	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	200000	
Styrene	ND	ug/kg	100000	
1,1,2,2-Tetrachloroethane	ND	ug/kg	100000	
Tetrachloroethene	ND	ug/kg	100000	
Toluene	2200000	ug/kg	100000	
1,1,1-Trichloroethane	ND	ug/kg	100000	
1,1,2-Trichloroethane	ND	ug/kg	100000	
Trichloroethene	ND	ug/kg	100000	
Vinyl acetate	ND	ug/kg	200000	
Vinyl chloride	ND	ug/kg	200000	
Xylenes (total)	ND	ug/kg	100000	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	4000000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-3 (1.5-3.5 feet)
Lab ID: 015127-0001-SA
Matrix: SOIL Sampled: 22 MAY 91 Received: 24 MAY 91
Authorized: 24 MAY 91 Prepared: 29 MAY 91 Analyzed: 01 JUN 91

Surrogate	Recovery	
Toluene-d8	ND	%
4-Bromofluorobenzene	ND	%
1,2-Dichloroethane-d4	ND	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-4 (8-10 feet)
Lab ID: 015127-0002-SA
Matrix: SOIL Sampled: 22 MAY 91 Received: 24 MAY 91
Authorized: 24 MAY 91 Prepared: 29 MAY 91 Analyzed: 02 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	2400	ug/kg	2000	
Benzene	ND	ug/kg	1000	
Bromodichloromethane	ND	ug/kg	1000	
Bromoform	ND	ug/kg	1000	
Bromomethane	ND	ug/kg	2000	
2-Butanone (MEK)	ND	ug/kg	2000	
Carbon disulfide	ND	ug/kg	1000	
Carbon tetrachloride	ND	ug/kg	1000	
Chlorobenzene	ND	ug/kg	1000	
Chloroethane	ND	ug/kg	2000	
Chloroform	ND	ug/kg	1000	
Chloromethane	ND	ug/kg	2000	
Dibromochloromethane	ND	ug/kg	1000	
1,1-Dichloroethane	ND	ug/kg	1000	
1,2-Dichloroethane	ND	ug/kg	1000	
1,1-Dichloroethene	ND	ug/kg	1000	
1,2-Dichloroethene (total)	ND	ug/kg	1000	
1,2-Dichloropropane	ND	ug/kg	1000	
cis-1,3-Dichloropropene	ND	ug/kg	1000	
trans-1,3-Dichloropropene	ND	ug/kg	1000	
Ethylbenzene	ND	ug/kg	1000	
2-Hexanone	ND	ug/kg	2000	
Methylene chloride	460	ug/kg	1000	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	2000	
Styrene	ND	ug/kg	1000	
1,1,2,2-Tetrachloroethane	ND	ug/kg	1000	
Tetrachloroethene	ND	ug/kg	1000	
Toluene	9500	ug/kg	1000	
1,1,1-Trichloroethane	ND	ug/kg	1000	
1,1,2-Trichloroethane	ND	ug/kg	1000	
Trichloroethene	ND	ug/kg	1000	
Vinyl acetate	ND	ug/kg	2000	
Vinyl chloride	ND	ug/kg	2000	
Xylenes (total)	ND	ug/kg	1000	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	40000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Cesar Rojas Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-4 (8-10 feet)
Lab ID: 015127-0002-SA
Matrix: SOIL Sampled: 22 MAY 91 Received: 24 MAY 91
Authorized: 24 MAY 91 Prepared: 29 MAY 91 Analyzed: 02 JUN 91

Surrogate	Recovery	
Toluene-d8	106	%
4-Bromofluorobenzene	102	%
1,2-Dichloroethane-d4	104	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Cesar Rojas Approved By: Mark Dymerski

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\% \text{ Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{\left| \text{Measured Concentration DCS1} - \text{Measured Concentration DCS2} \right|}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

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A Corning Company

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC/MS

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
015127-0001-SA	SOIL	8240-S	13 MAY 91-A	29 MAY 91-A
015127-0002-SA	SOIL	8240-S	29 MAY 91-A	29 MAY 91-A

Enseco
A Corning Company

DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	Measured AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Precision Limit
Category: 8240-S Matrix: SOIL QC Lot: 13 MAY 91-A Concentration Units: ug/kg								
1,1-Dichloroethene	5000	4500	4120	4310	86	59-172	8.8	22
Trichloroethene	5000	5340	5170	5260	105	62-137	3.2	24
Benzene	5000	5750	5750	5750	115	66-142	0.0	21
Toluene	5000	6030	5900	5960	119	59-139	2.2	21
Chlorobenzene	5000	5870	5810	5840	117	60-133	1.0	21
Category: 8240-S Matrix: SOIL QC Lot: 29 MAY 91-A Concentration Units: ug/kg								
1,1-Dichloroethene	5000	3780	3460	3620	72	59-172	8.8	22
Trichloroethene	5000	4580	4570	4580	92	62-137	0.2	24
Benzene	5000	4540	4790	4660	93	66-142	5.4	21
Toluene	5000	4960	5140	5050	101	59-139	3.6	21
Chlorobenzene	5000	4680	4920	4800	96	60-133	5.0	21

Calculations are performed before rounding to avoid round-off errors in calculated results.

Enseco
A Corning Company

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 8240-S Matrix: SOIL QC Lot: 13 MAY 91-A QC Run: 29 MAY 91-A Concentration Units: ug/kg				
1,2-Dichloroethane-d4	5000	5930	119	70-121
4-Bromofluorobenzene	5000	5510	110	74-121
Toluene-d8	5000	5830	117	81-117
Category: 8240-S Matrix: SOIL QC Lot: 29 MAY 91-A QC Run: 29 MAY 91-A Concentration Units: ug/kg				
1,2-Dichloroethane-d4	5000	5930	119	70-121
4-Bromofluorobenzene	5000	5510	110	74-121
Toluene-d8	5000	5830	117	81-117

Calculations are performed before rounding to avoid round-off errors in calculated results.

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A Corning Company

METHOD BLANK REPORT
Volatile Organics by GC/MS

Test: 8240CPM-TCL-S
Matrix: SOIL
QC Lot: 13 MAY 91-A QC Run: 29 MAY 91-A

Analyte	Result	Units	Reporting Limit
Acetone	ND	ug/kg	1000
Benzene	ND	ug/kg	500
Bromodichloromethane	ND	ug/kg	500
Bromoform	ND	ug/kg	500
Bromomethane	ND	ug/kg	1000
2-Butanone (MEK)	ND	ug/kg	1000
Carbon disulfide	ND	ug/kg	500
Carbon tetrachloride	ND	ug/kg	500
Chlorobenzene	ND	ug/kg	500
Chloroethane	ND	ug/kg	1000
Chloroform	ND	ug/kg	500
Chloromethane	ND	ug/kg	1000
Dibromochloromethane	ND	ug/kg	500
1,1-Dichloroethane	ND	ug/kg	500
1,2-Dichloroethane	ND	ug/kg	500
1,1-Dichloroethene	ND	ug/kg	500
1,2-Dichloroethene (total)	ND	ug/kg	500
1,2-Dichloropropane	ND	ug/kg	500
cis-1,3-Dichloropropene	ND	ug/kg	500
trans-1,3-Dichloropropene	ND	ug/kg	500
Ethylbenzene	ND	ug/kg	500
2-Hexanone	ND	ug/kg	1000
Methylene chloride	ND	ug/kg	500
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	1000
Styrene	ND	ug/kg	500
1,1,2,2-Tetrachloroethane	ND	ug/kg	500
Tetrachloroethene	ND	ug/kg	500
Toluene	ND	ug/kg	500
1,1,1-Trichloroethane	ND	ug/kg	500
1,1,2-Trichloroethane	ND	ug/kg	500
Trichloroethene	ND	ug/kg	500
Vinyl acetate	ND	ug/kg	1000
Vinyl chloride	ND	ug/kg	1000
Xylenes (total)	ND	ug/kg	500
Hexane	ND	ug/kg	--
n-Butyl alcohol	ND	ug/kg	--
Isobutanol	ND	ug/kg	20000

METHOD BLANK REPORT
Volatile Organics by GC/MS (cont.)

Test: 8240CPM-TCL-S
Matrix: SOIL
QC Lot: 29 MAY 91-A QC Run: 29 MAY 91-A

Analyte	Result	Units	Reporting Limit
Acetone	ND	ug/kg	1000
Benzene	ND	ug/kg	500
Bromodichloromethane	ND	ug/kg	500
Bromoform	ND	ug/kg	500
Bromomethane	ND	ug/kg	1000
2-Butanone (MEK)	ND	ug/kg	1000
Carbon disulfide	ND	ug/kg	500
Carbon tetrachloride	ND	ug/kg	500
Chlorobenzene	ND	ug/kg	500
Chloroethane	ND	ug/kg	1000
Chloroform	ND	ug/kg	500
Chloromethane	ND	ug/kg	1000
Dibromochloromethane	ND	ug/kg	500
1,1-Dichloroethane	ND	ug/kg	500
1,2-Dichloroethane	ND	ug/kg	500
1,1-Dichloroethene	ND	ug/kg	500
1,2-Dichloroethene (total)	ND	ug/kg	500
1,2-Dichloropropane	ND	ug/kg	500
cis-1,3-Dichloropropene	ND	ug/kg	500
trans-1,3-Dichloropropene	ND	ug/kg	500
Ethylbenzene	ND	ug/kg	500
2-Hexanone	ND	ug/kg	1000
Methylene chloride	ND	ug/kg	500
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	1000
Styrene	ND	ug/kg	500
1,1,2,2-Tetrachloroethane	ND	ug/kg	500
Tetrachloroethene	ND	ug/kg	500
Toluene	ND	ug/kg	500
1,1,1-Trichloroethane	ND	ug/kg	500
1,1,2-Trichloroethane	ND	ug/kg	500
Trichloroethene	ND	ug/kg	500
Vinyl acetate	ND	ug/kg	1000
Vinyl chloride	ND	ug/kg	1000
Xylenes (total)	ND	ug/kg	500
Hexane	ND	ug/kg	--
n-Butyl alcohol	ND	ug/kg	--
Isobutanol	ND	ug/kg	20000

Appendix

CHAIN OF CUSTODY RECORD

WOODWARD-CLYDE CONSULTANTS • 5055 ANTIOCH ROAD • OVERLAND PARK, KANSAS 66203 • 913-432-4242

SAMPLER(S)	PROJECT NAME	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET
CHRISTOPHER FITZGERALD	SHELLER-GLOBE KEOKUK IOWA	22 / 5 / 91	1 of 1

CONTENTS OF SHIPMENT

SAMPLE NUMBER	TYPE OF CONTAINERS: CUBITAINER	BOTTLE (NUMBERS OF CONTAINERS PER SAMPLE NUMBER)	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers etc.)
WCS-3											** NOTE **
(1.5-3.5 Feet)		1					X				Collected on 5-22-91
WCS-4											
(8-10 Feet)		1					X				Collected on 5-22-91
											PLEASE NOTE:
											BOTH OF THESE
											SAMPLES ARE TO BE
											ANALYZED FOR VOA
											(METHOD 8240) PLUS
											METHYL ISOBUTYL KETONE,
											n-HEXANE, & BUTANOL

DESCRIPTION OF SHIPMENT

1 PIECE(S) CONSISTING OF 1 ICE CHEST(S)

RECEIVING LABORATORY: ENSECO - RMAL

MODE OF SHIPMENT

1 COMMERCIAL CARRIER: FEDERAL EXPRESS

__ COURIER

__ SAMPLER CONVEYED

0698250254 (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
Christopher Fitzgerald ☒ SEALED ☐ UNSEALED	5-23-91	8.00	FEDERAL EXPRESS ☒ SEALED ☐ UNSEALED	SHIP TO LABORATORY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY Justa Chappell 5/24/91 0805 ☐ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY ☐ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY

Rocky Mountain
Analytical Laboratory

3/6

Enseco
A CORNING Company

June 12, 1991

Mr. David Dods
Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Dear Mr. Dods:

Enclosed is the report for five samples received at Enseco-Rocky Mountain Analytical Laboratory on May 25, 1991.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Julie Essey
Program Administrator

Reviewed by:

Sue Dalla
Manager
Program Administration

JE/SD/dmh
Enclosures

RMAL #015140

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

Enseco

ANALYTICAL RESULTS

FOR

WOODWARD-CLYDE CONSULTANTS

ENSECO-RMAL NO. 015140

JUNE 12, 1991

Reviewed by:

Julie Essey

Sue Dalla

Sue Dalla

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

Pursuant to instructions from Woodward-Clyde Consultants on May 29, 1991, sample 015140-0005 was canceled for volatiles analysis and reassigned for Total Organic Carbon (TOC) testing instead; this analysis has been given a new project number.

"J" values have been reported for the volatiles, semivolatiles, and metals analyses. A "J" value indicates an estimated value. For Methods 8240 and 8270 a "J" value is where the mass spectra data indicate the presence of a compound which meets identification criteria; however, the result is less than the reporting limit but greater than the instrument detection limit (IDL).

All analyses at Enseco are performed so that the maximum concentration of sample consistent with the method is analyzed. Dilutions are at times required to avoid saturation of the detector, to achieve linearity for a specific target compound or to reduce matrix interferences. In this event, reporting limits are adjusted proportionately. Surrogate compounds may not be measurable in samples which have been diluted.

Samples 015140-0001 and -0003 by Method 8240 were prepared as medium level soils based on the screening data. Both samples were further diluted due to elevated concentrations of target compounds.

Sample 015140-0002 by Method 8240 resulted in a high surrogate recovery for toluene-d8. The sample was reanalyzed confirming the original results, indicating matrix effect. Target compounds like toluene-d8 may also be biased high.

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

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SAMPLE DESCRIPTION INFORMATION
for
Woodward-Clyde Consultants

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
015140-0001-SA	WCS-8 (8-10')	SOIL	23 MAY 91		25 MAY 91
015140-0002-SA	WCS-7 (1-3')	SOIL	23 MAY 91		25 MAY 91
015140-0003-SA	MW-9 (15-17')	SOIL	23 MAY 91		25 MAY 91
015140-0004-SA	WCS-9 (8-10')	SOIL	24 MAY 91		25 MAY 91
015140-0005-SA	MW-12 (35-37')	SOIL	24 MAY 91		25 MAY 91

Enseco
A Corning Company

ANALYTICAL TEST REQUESTS
for
Woodward-Clyde Consultants

Lab ID: 015140	Group Code	Analysis Description	Custom Test?
0001 - 0004	A	Volatile Organics	Y
		Target Compound List (TCL)	Y
		GC Screen For Low Level Soils	N
		Volatile Organics	Y
		Target Compound List (TCL)	Y
		VOA Screen for Medium Level Soils	N

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, May, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-8 (8-10')
Lab ID: 015140-0001-SA
Matrix: SOIL Sampled: 23 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	5300	ug/kg	6700	J
Benzene	ND	ug/kg	3400	
Bromodichloromethane	ND	ug/kg	3400	
Bromoform	ND	ug/kg	3400	
Bromomethane	ND	ug/kg	6700	
2-Butanone (MEK)	ND	ug/kg	6700	
Carbon disulfide	ND	ug/kg	3400	
Carbon tetrachloride	ND	ug/kg	3400	
Chlorobenzene	ND	ug/kg	3400	
Chloroethane	ND	ug/kg	6700	
Chloroform	ND	ug/kg	3400	
Chloromethane	ND	ug/kg	6700	
Dibromochloromethane	ND	ug/kg	3400	
1,1-Dichloroethane	ND	ug/kg	3400	
1,2-Dichloroethane	ND	ug/kg	3400	
1,1-Dichloroethene	ND	ug/kg	3400	
1,2-Dichloroethene (total)	ND	ug/kg	3400	
1,2-Dichloropropane	ND	ug/kg	3400	
cis-1,3-Dichloropropene	ND	ug/kg	3400	
trans-1,3-Dichloropropene	ND	ug/kg	3400	
Ethylbenzene	ND	ug/kg	3400	
2-Hexanone	ND	ug/kg	6700	
Methylene chloride	1100	ug/kg	3400	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	6700	
Styrene	ND	ug/kg	3400	
1,1,2,2-Tetrachloroethane	ND	ug/kg	3400	
Tetrachloroethene	ND	ug/kg	3400	
Toluene	58000	ug/kg	3400	
1,1,1-Trichloroethane	ND	ug/kg	3400	
1,1,2-Trichloroethane	ND	ug/kg	3400	
Trichloroethene	ND	ug/kg	3400	
Vinyl acetate	ND	ug/kg	6700	
Vinyl chloride	ND	ug/kg	6700	
Xylenes (total)	ND	ug/kg	3400	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	130000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Cesar Rojas Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-8 (8-10')
Lab ID: 015140-0001-SA
Matrix: SOIL Sampled: 23 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Surrogate	Recovery	
Toluene-d8	111	%
4-Bromofluorobenzene	106	%
1,2-Dichloroethane-d4	112	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Cesar Rojas Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-7 (1-3')
Lab ID: 015140-0002-SA
Matrix: SOIL Sampled: 23 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	240	ug/kg	10	
Benzene	4.5	ug/kg	5.0	J
Bromodichloromethane	ND	ug/kg	5.0	
Bromoform	ND	ug/kg	5.0	
Bromomethane	ND	ug/kg	10	
2-Butanone (MEK)	36	ug/kg	10	
Carbon disulfide	2.0	ug/kg	5.0	J
Carbon tetrachloride	ND	ug/kg	5.0	
Chlorobenzene	ND	ug/kg	5.0	
Chloroethane	ND	ug/kg	10	
Chloroform	ND	ug/kg	5.0	
Chloromethane	ND	ug/kg	10	
Dibromochloromethane	ND	ug/kg	5.0	
1,1-Dichloroethane	12	ug/kg	5.0	
1,2-Dichloroethane	ND	ug/kg	5.0	
1,1-Dichloroethene	1.5	ug/kg	5.0	J
1,2-Dichloroethene (total)	ND	ug/kg	5.0	
1,2-Dichloropropane	ND	ug/kg	5.0	
cis-1,3-Dichloropropene	ND	ug/kg	5.0	
trans-1,3-Dichloropropene	ND	ug/kg	5.0	
Ethylbenzene	15	ug/kg	5.0	
2-Hexanone	ND	ug/kg	10	
Methylene chloride	32	ug/kg	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	10	
Styrene	ND	ug/kg	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/kg	5.0	
Tetrachloroethene	ND	ug/kg	5.0	
Toluene	72	ug/kg	5.0	
1,1,1-Trichloroethane	ND	ug/kg	5.0	
1,1,2-Trichloroethane	ND	ug/kg	5.0	
Trichloroethene	ND	ug/kg	5.0	
Vinyl acetate	ND	ug/kg	10	
Vinyl chloride	ND	ug/kg	10	
Xylenes (total)	190	ug/kg	5.0	
Hexane	2.6	ug/kg	--	J
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Keith Beauvais Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-7 (1-3')
Lab ID: 015140-0002-SA
Matrix: SOIL Sampled: 23 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Surrogate	Recovery	
Toluene-d8	134	%
4-Bromofluorobenzene	74	%
1,2-Dichloroethane-d4	99	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Keith Beauvais Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-9 (15-17')
Lab ID: 015140-0003-SA
Matrix: SOIL Sampled: 23 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	4000	ug/kg	5000	J
Benzene	ND	ug/kg	2500	
Bromodichloromethane	ND	ug/kg	2500	
Bromoform	ND	ug/kg	2500	
Bromomethane	ND	ug/kg	5000	
2-Butanone (MEK)	ND	ug/kg	5000	
Carbon disulfide	ND	ug/kg	2500	
Carbon tetrachloride	ND	ug/kg	2500	
Chlorobenzene	ND	ug/kg	2500	
Chloroethane	ND	ug/kg	5000	
Chloroform	ND	ug/kg	2500	
Chloromethane	ND	ug/kg	5000	
Dibromochloromethane	ND	ug/kg	2500	
1,1-Dichloroethane	ND	ug/kg	2500	
1,2-Dichloroethane	ND	ug/kg	2500	
1,1-Dichloroethene	ND	ug/kg	2500	
1,2-Dichloroethene (total)	ND	ug/kg	2500	
1,2-Dichloropropane	ND	ug/kg	2500	
cis-1,3-Dichloropropene	ND	ug/kg	2500	
trans-1,3-Dichloropropene	ND	ug/kg	2500	
Ethylbenzene	ND	ug/kg	2500	
2-Hexanone	ND	ug/kg	5000	
Methylene chloride	540	ug/kg	2500	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	5000	
Styrene	ND	ug/kg	2500	
1,1,2,2-Tetrachloroethane	ND	ug/kg	2500	
Tetrachloroethene	ND	ug/kg	2500	
Toluene	13000	ug/kg	2500	
1,1,1-Trichloroethane	ND	ug/kg	2500	
1,1,2-Trichloroethane	ND	ug/kg	2500	
Trichloroethene	ND	ug/kg	2500	
Vinyl acetate	ND	ug/kg	5000	
Vinyl chloride	ND	ug/kg	5000	
Xylenes (total)	ND	ug/kg	2500	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	100000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Deneen Spence Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-9 (15-17')
Lab ID: 015140-0003-SA
Matrix: SOIL Sampled: 23 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Surrogate	Recovery	
Toluene-d8	112	%
4-Bromofluorobenzene	111	%
1,2-Dichloroethane-d4	106	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Deneen Spence Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-9 (8-10')
Lab ID: 015140-0004-SA
Matrix: SOIL Sampled: 24 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	22	ug/kg	10	
Benzene	ND	ug/kg	5.0	
Bromodichloromethane	ND	ug/kg	5.0	
Bromoform	ND	ug/kg	5.0	
Bromomethane	ND	ug/kg	10	
2-Butanone (MEK)	ND	ug/kg	10	
Carbon disulfide	ND	ug/kg	5.0	
Carbon tetrachloride	ND	ug/kg	5.0	
Chlorobenzene	ND	ug/kg	5.0	
Chloroethane	ND	ug/kg	10	
Chloroform	ND	ug/kg	5.0	
Chloromethane	ND	ug/kg	10	
Dibromochloromethane	ND	ug/kg	5.0	
1,1-Dichloroethane	ND	ug/kg	5.0	
1,2-Dichloroethane	ND	ug/kg	5.0	
1,1-Dichloroethene	ND	ug/kg	5.0	
1,2-Dichloroethene (total)	ND	ug/kg	5.0	
1,2-Dichloropropane	ND	ug/kg	5.0	
cis-1,3-Dichloropropene	ND	ug/kg	5.0	
trans-1,3-Dichloropropene	ND	ug/kg	5.0	
Ethylbenzene	ND	ug/kg	5.0	
2-Hexanone	ND	ug/kg	10	
Methylene chloride	1.9	ug/kg	5.0	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	10	
Styrene	ND	ug/kg	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/kg	5.0	
Tetrachloroethene	ND	ug/kg	5.0	
Toluene	ND	ug/kg	5.0	
1,1,1-Trichloroethane	ND	ug/kg	5.0	
1,1,2-Trichloroethane	ND	ug/kg	5.0	
Trichloroethene	ND	ug/kg	5.0	
Vinyl acetate	ND	ug/kg	10	
Vinyl chloride	ND	ug/kg	10	
Xylenes (total)	ND	ug/kg	5.0	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Keith Beauvais Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-9 (8-10')
Lab ID: 015140-0004-SA
Matrix: SOIL Sampled: 24 MAY 91 Received: 25 MAY 91
Authorized: 25 MAY 91 Prepared: 28 MAY 91 Analyzed: 03 JUN 91

Surrogate	Recovery	
Toluene-d8	100	%
4-Bromofluorobenzene	97	%
1,2-Dichloroethane-d4	98	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Keith Beauvais Approved By: Mark Dymerski

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\% \text{ Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{\left| \text{Measured Concentration DCS1} - \text{Measured Concentration DCS2} \right|}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

Enseco
A Corning Company

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC/MS

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
015140-0001-SA	SOIL	8240-S	29 MAY 91-A	29 MAY 91-A
015140-0002-SA	SOIL	8240-SL	28 MAY 91-L	03 JUN 91-L2
015140-0003-SA	SOIL	8240-S	29 MAY 91-A	29 MAY 91-B
015140-0004-SA	SOIL	8240-SL	28 MAY 91-L	03 JUN 91-L2

Enseco
A Corning Company

DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	Measured AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Limit
Category: 8240-S Matrix: SOIL QC Lot: 29 MAY 91-A Concentration Units: ug/kg								
1,1-Dichloroethene	5000	3780	3460	3620	72	59-172	8.8	22
Trichloroethene	5000	4580	4570	4580	92	62-137	0.2	24
Benzene	5000	4540	4790	4660	93	66-142	5.4	21
Toluene	5000	4960	5140	5050	101	59-139	3.6	21
Chlorobenzene	5000	4680	4920	4800	96	60-133	5.0	21
Category: 8240-SL Matrix: SOIL QC Lot: 28 MAY 91-L Concentration Units: ug/Kg								
1,1-Dichloroethene	50	47.9	46.1	47.0	94	59-172	3.8	22
Trichloroethene	50	48.0	45.6	46.8	94	62-137	5.1	24
Benzene	50	52.3	48.7	50.5	101	66-142	7.1	21
Toluene	50	54.8	49.8	52.3	105	59-139	9.6	21
Chlorobenzene	50	53.1	49.0	51.0	102	60-133	8.0	21

Calculations are performed before rounding to avoid round-off errors in calculated results.

Enseco
A Corning Company

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 8240-S Matrix: SOIL QC Lot: 29 MAY 91-A QC Run: 29 MAY 91-A Concentration Units: ug/kg				
1,2-Dichloroethane-d4	5000	5930	119	70-121
4-Bromofluorobenzene	5000	5510	110	74-121
Toluene-d8	5000	5830	117	81-117
Category: 8240-SL Matrix: SOIL QC Lot: 28 MAY 91-L QC Run: 03 JUN 91-L2 Concentration Units: ug/Kg				
1,2-Dichloroethane-d4	50.0	48.8	98	70-121
4-Bromofluorobenzene	50.0	48.8	98	74-121
Toluene-d8	50.0	50.4	101	81-117
Category: 8240-S Matrix: SOIL QC Lot: 29 MAY 91-A QC Run: 29 MAY 91-B Concentration Units: ug/kg				
1,2-Dichloroethane-d4	5000	5600	112	70-121
4-Bromofluorobenzene	5000	5520	110	74-121
Toluene-d8	5000	5800	116	81-117

Calculations are performed before rounding to avoid round-off errors in calculated results.

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METHOD BLANK REPORT
Volatile Organics by GC/MS

Test: 8240CPM-TCL-S
Matrix: SOIL
QC Lot: 29 MAY 91-A QC Run: 29 MAY 91-A

Analyte	Result	Units	Reporting Limit
Acetone	ND	ug/kg	1000
Benzene	ND	ug/kg	500
Bromodichloromethane	ND	ug/kg	500
Bromoform	ND	ug/kg	500
Bromomethane	ND	ug/kg	1000
2-Butanone (MEK)	ND	ug/kg	1000
Carbon disulfide	ND	ug/kg	500
Carbon tetrachloride	ND	ug/kg	500
Chlorobenzene	ND	ug/kg	500
Chloroethane	ND	ug/kg	1000
Chloroform	ND	ug/kg	500
Chloromethane	ND	ug/kg	1000
Dibromochloromethane	ND	ug/kg	500
1,1-Dichloroethane	ND	ug/kg	500
1,2-Dichloroethane	ND	ug/kg	500
1,1-Dichloroethene	ND	ug/kg	500
1,2-Dichloroethene (total)	ND	ug/kg	500
1,2-Dichloropropane	ND	ug/kg	500
cis-1,3-Dichloropropene	ND	ug/kg	500
trans-1,3-Dichloropropene	ND	ug/kg	500
Ethylbenzene	ND	ug/kg	500
2-Hexanone	ND	ug/kg	1000
Methylene chloride	ND	ug/kg	500
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	1000
Styrene	ND	ug/kg	500
1,1,2,2-Tetrachloroethane	ND	ug/kg	500
Tetrachloroethene	ND	ug/kg	500
Toluene	ND	ug/kg	500
1,1,1-Trichloroethane	ND	ug/kg	500
1,1,2-Trichloroethane	ND	ug/kg	500
Trichloroethene	ND	ug/kg	500
Vinyl acetate	ND	ug/kg	1000
Vinyl chloride	ND	ug/kg	1000
Xylenes (total)	ND	ug/kg	500
Hexane	ND	ug/kg	--
n-Butyl alcohol	ND	ug/kg	--
Isobutanol	ND	ug/kg	20000

METHOD BLANK REPORT
Volatile Organics by GC/MS (cont.)

Test: 8240CPL-TCL-S
Matrix: SOIL
QC Lot: 28 MAY 91-L QC Run: 03 JUN 91-L2

Analyte	Result	Units	Reporting Limit	
Acetone	6.8	ug/kg	10	J
Benzene	ND	ug/kg	5.0	
Bromodichloromethane	ND	ug/kg	5.0	
Bromoform	ND	ug/kg	5.0	
Bromomethane	ND	ug/kg	10	
2-Butanone (MEK)	ND	ug/kg	10	
Carbon disulfide	ND	ug/kg	5.0	
Carbon tetrachloride	ND	ug/kg	5.0	
Chlorobenzene	ND	ug/kg	5.0	
Chloroethane	ND	ug/kg	10	
Chloroform	ND	ug/kg	5.0	
Chloromethane	ND	ug/kg	10	
Dibromochloromethane	ND	ug/kg	5.0	
1,1-Dichloroethane	ND	ug/kg	5.0	
1,2-Dichloroethane	ND	ug/kg	5.0	
1,1-Dichloroethene	ND	ug/kg	5.0	
1,2-Dichloroethene (total)	ND	ug/kg	5.0	
1,2-Dichloropropane	ND	ug/kg	5.0	
cis-1,3-Dichloropropene	ND	ug/kg	5.0	
trans-1,3-Dichloropropene	ND	ug/kg	5.0	
Ethylbenzene	ND	ug/kg	5.0	
2-Hexanone	ND	ug/kg	10	
Methylene chloride	ND	ug/kg	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	10	
Styrene	ND	ug/kg	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/kg	5.0	
Tetrachloroethene	ND	ug/kg	5.0	
Toluene	ND	ug/kg	5.0	
1,1,1-Trichloroethane	ND	ug/kg	5.0	
1,1,2-Trichloroethane	ND	ug/kg	5.0	
Trichloroethene	ND	ug/kg	5.0	
Vinyl acetate	ND	ug/kg	10	
Vinyl chloride	ND	ug/kg	10	
Xylenes (total)	ND	ug/kg	5.0	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	200	

METHOD BLANK REPORT
Volatile Organics by GC/MS (cont.)

Test: 8240CPM-TCL-S
Matrix: SOIL
QC Lot: 29 MAY 91-A QC Run: 29 MAY 91-B

Analyte	Result	Units	Reporting Limit	
Acetone	ND	ug/kg	1000	
Benzene	ND	ug/kg	500	
Bromodichloromethane	ND	ug/kg	500	
Bromoform	ND	ug/kg	500	
Bromomethane	ND	ug/kg	1000	
2-Butanone (MEK)	ND	ug/kg	1000	
Carbon disulfide	ND	ug/kg	500	
Carbon tetrachloride	ND	ug/kg	500	
Chlorobenzene	ND	ug/kg	500	
Chloroethane	ND	ug/kg	1000	
Chloroform	ND	ug/kg	500	
Chloromethane	ND	ug/kg	1000	
Dibromochloromethane	ND	ug/kg	500	
1,1-Dichloroethane	ND	ug/kg	500	
1,2-Dichloroethane	ND	ug/kg	500	
1,1-Dichloroethene	ND	ug/kg	500	
1,2-Dichloroethene (total)	ND	ug/kg	500	
1,2-Dichloropropane	ND	ug/kg	500	
cis-1,3-Dichloropropene	ND	ug/kg	500	
trans-1,3-Dichloropropene	ND	ug/kg	500	
Ethylbenzene	ND	ug/kg	500	
2-Hexanone	ND	ug/kg	1000	
Methylene chloride	141	ug/kg	500	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	1000	
Styrene	ND	ug/kg	500	
1,1,2,2-Tetrachloroethane	ND	ug/kg	500	
Tetrachloroethene	ND	ug/kg	500	
Toluene	ND	ug/kg	500	
1,1,1-Trichloroethane	ND	ug/kg	500	
1,1,2-Trichloroethane	ND	ug/kg	500	
Trichloroethene	ND	ug/kg	500	
Vinyl acetate	ND	ug/kg	1000	
Vinyl chloride	ND	ug/kg	1000	
Xylenes (total)	ND	ug/kg	500	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	20000	

Appendix

CHAIN OF CUSTODY RECORD

WOODWARD-CLYDE CONSULTANTS • 5055 ANTIOCH ROAD • OVERLAND PARK, KANSAS 66203 • 913-432-4242

SAMPLER(S)	PROJECT NAME	DATE OF COLLECTION	SHEET
CHRIS FITZGERALD	SHELLER-GLOBE KEOKUK IOWA	24 DAY 05 MONTH 91 YEAR	1 of 1

CONTENTS OF SHIPMENT

SAMPLE NUMBER	TYPE OF CONTAINERS: CUBITAINER	8oz BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
	NUMBERS OF CONTAINERS PER SAMPLE NUMBER										
WCS-8							X				NOTE: * *
(8-10ft)		1					X				Collected 5-23-91
WCS-7											
(1-3 Feet)		1					X				Collected 5-23-91
MW-9											
(15-17ft)		1					X				Collected 5-23-91
WCS-9											
(8-10ft)		1					X				Collected 5-24-91
MW-12 *											
(35-37)		1					X				Collected 5-24-91
→ Please call DAVID DODS											
AT WOODWARD-CLYDE CONSULTANTS											Please Note:
PRIOR TO ANALYZING THIS SAMPLE.											The ~~3~~ 4 SAMPLES
(913) 432-4242											LISTED ABOVE ARE
											TO BE ANALYZED
											FOR VOA (8240)
											PLUS METHYL ISOBUTYL
											KETONE, n-HEXANE
											AND BUTANOL

DESCRIPTION OF SHIPMENT

1 PIECE(S) CONSISTING OF 1 ICE CHEST(S)

RECEIVING LABORATORY: ENSECO - RMAL

MODE OF SHIPMENT

X COMMERCIAL CARRIER: FEDERAL EXPRESS

__ COURIER

__ SAMPLER CONVEYED

0698250232 (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
Christopher J. Fitzgerald ☒ SEALED ☐ UNSEALED	5-24-91	16:00	FEDERAL EXPRESS ☒ SEALED ☐ UNSEALED	SHIP TO LABORATORY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY 5/25/91 0920 ☐ SEALED ☒ UNSEALED	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY ☐ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY

Rocky Mountain
Analytical Laboratory

Enseco
A CORNING Company

June 13, 1991

Mr. David Dods
Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Dear Mr. Dods:

Enclosed is the report for three samples received at Enseco-Rocky Mountain Analytical Laboratory on May 30, 1991.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Julie Essey
Program Administrator

Reviewed by:

Sue Dalta
Manager
Program Administration

JE/SD/heg
Enclosures

RMAL #015168

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

Enseco

ANALYTICAL RESULTS

FOR

WOODWARD-CLYDE CONSULTANTS

ENSECO-RMAL NO. 015168

JUNE 13, 1991

Reviewed by: Julie Essey

Julie Essey

Sue Dalla

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

"J" values have been reported for the volatiles, semivolatiles and metals analyses. A "J" value indicates an estimated value. For Methods 8240 and 8270 a "J" value is where the mass spectra data indicate the presence of a compound which meets identification criteria; however, the result is less than the reporting limit but greater than the instrument detection limit (IDL). All analyses at Enseco are performed so that the maximum concentration of sample consistent with the method is analyzed. Dilutions are at times required to avoid saturation of the detector, to achieve linearity for a specific target compound or to reduce matrix interferences. In this event, reporting limits are adjusted proportionately. Surrogate compounds may not be measurable in samples which have been diluted.

Samples 015168-0001 through -0003 by Method 8240 were prepared as medium level soils based on the screening data. These samples were further diluted due to elevated concentrations of target compounds. The surrogates for samples -0001 and -0002 were not recovered and are, therefore, reported as ND (not detected).

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

Enseco
A Corning Company

SAMPLE DESCRIPTION INFORMATION
for
Woodward-Clyde Consultants

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
015168-0001-SA	WCS-2 (8-10 Feet)	SOIL	28 MAY 91		30 MAY 91
015168-0002-SA	WCS-5 (8-10 Feet)	SOIL	28 MAY 91		30 MAY 91
015168-0003-SA	WCS-6 (8-10 Feet)	SOIL	28 MAY 91		30 MAY 91

Enseco
A Corning Company

ANALYTICAL TEST REQUESTS
for
Woodward-Clyde Consultants

Lab ID: 015168	Group Code	Analysis Description	Custom Test?
0001 - 0003	A	Volatile Organics	Y
		Target Compound List (TCL)	Y
		GC Screen For Low Level Soils	N
		Volatile Organics	Y
		Target Compound List (TCL)	Y
		VOA Screen for Medium Level Soils	N

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, May, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-2 (8-10 Feet)
Lab ID: 015168-0001-SA
Matrix: SOIL Sampled: 28 MAY 91 Received: 30 MAY 91
Authorized: 30 MAY 91 Prepared: 03 JUN 91 Analyzed: 07 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	26000	ug/kg	33000	J
Benzene	ND	ug/kg	16000	
Bromodichloromethane	ND	ug/kg	16000	
Bromoform	ND	ug/kg	16000	
Bromomethane	ND	ug/kg	33000	
2-Butanone (MEK)	ND	ug/kg	33000	
Carbon disulfide	ND	ug/kg	16000	
Carbon tetrachloride	ND	ug/kg	16000	
Chlorobenzene	ND	ug/kg	16000	
Chloroethane	ND	ug/kg	33000	
Chloroform	ND	ug/kg	16000	
Chloromethane	ND	ug/kg	33000	
Dibromochloromethane	ND	ug/kg	16000	
1,1-Dichloroethane	ND	ug/kg	16000	
1,2-Dichloroethane	ND	ug/kg	16000	
1,1-Dichloroethene	ND	ug/kg	16000	
1,2-Dichloroethene (total)	ND	ug/kg	16000	
1,2-Dichloropropane	ND	ug/kg	16000	
cis-1,3-Dichloropropene	ND	ug/kg	16000	
trans-1,3-Dichloropropene	ND	ug/kg	16000	
Ethylbenzene	ND	ug/kg	16000	
2-Hexanone	ND	ug/kg	33000	
Methylene chloride	4600	ug/kg	16000	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	33000	
Styrene	ND	ug/kg	16000	
1,1,2,2-Tetrachloroethane	ND	ug/kg	16000	
Tetrachloroethene	ND	ug/kg	16000	
Toluene	320000	ug/kg	16000	
1,1,1-Trichloroethane	ND	ug/kg	16000	
1,1,2-Trichloroethane	ND	ug/kg	16000	
Trichloroethene	ND	ug/kg	16000	
Vinyl acetate	ND	ug/kg	33000	
Vinyl chloride	ND	ug/kg	33000	
Xylenes (total)	ND	ug/kg	16000	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	660000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-2 (8-10 Feet)
Lab ID: 015168-0001-SA
Matrix: SOIL
Authorized: 30 MAY 91

Sampled: 28 MAY 91
Prepared: 03 JUN 91

Received: 30 MAY 91
Analyzed: 07 JUN 91

Surrogate	Recovery	
Toluene-d8	ND	%
4-Bromofluorobenzene	ND	%
1,2-Dichloroethane-d4	ND	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz

Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-5 (8-10 Feet)
Lab ID: 015168-0002-SA
Matrix: SOIL Sampled: 28 MAY 91 Received: 30 MAY 91
Authorized: 30 MAY 91 Prepared: 03 JUN 91 Analyzed: 07 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	98000	ug/kg	200000	J
Benzene	ND	ug/kg	100000	
Bromodichloromethane	ND	ug/kg	100000	
Bromoform	ND	ug/kg	100000	
Bromomethane	ND	ug/kg	200000	
2-Butanone (MEK)	ND	ug/kg	200000	
Carbon disulfide	ND	ug/kg	100000	
Carbon tetrachloride	ND	ug/kg	100000	
Chlorobenzene	ND	ug/kg	100000	
Chloroethane	ND	ug/kg	200000	
Chloroform	ND	ug/kg	100000	
Chloromethane	ND	ug/kg	200000	
Dibromochloromethane	ND	ug/kg	100000	
1,1-Dichloroethane	ND	ug/kg	100000	
1,2-Dichloroethane	ND	ug/kg	100000	
1,1-Dichloroethene	ND	ug/kg	100000	
1,2-Dichloroethene (total)	ND	ug/kg	100000	
1,2-Dichloropropane	ND	ug/kg	100000	
cis-1,3-Dichloropropene	ND	ug/kg	100000	
trans-1,3-Dichloropropene	ND	ug/kg	100000	
Ethylbenzene	ND	ug/kg	100000	
2-Hexanone	ND	ug/kg	200000	
Methylene chloride	24000	ug/kg	100000	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	200000	
Styrene	ND	ug/kg	100000	
1,1,2,2-Tetrachloroethane	ND	ug/kg	100000	
Tetrachloroethene	ND	ug/kg	100000	
Toluene	1900000	ug/kg	100000	
1,1,1-Trichloroethane	ND	ug/kg	100000	
1,1,2-Trichloroethane	ND	ug/kg	100000	
Trichloroethene	ND	ug/kg	100000	
Vinyl acetate	ND	ug/kg	200000	
Vinyl chloride	ND	ug/kg	200000	
Xylenes (total)	ND	ug/kg	100000	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	4000000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-5 (8-10 Feet)
Lab ID: 015168-0002-SA
Matrix: SOIL Sampled: 28 MAY 91 Received: 30 MAY 91
Authorized: 30 MAY 91 Prepared: 03 JUN 91 Analyzed: 07 JUN 91

Surrogate	Recovery	
Toluene-d8	ND	%
4-Bromofluorobenzene	ND	%
1,2-Dichloroethane-d4	ND	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-6 (8-10 Feet)
Lab ID: 015168-0003-SA
Matrix: SOIL Sampled: 28 MAY 91 Received: 30 MAY 91
Authorized: 30 MAY 91 Prepared: 03 JUN 91 Analyzed: 07 JUN 91

Parameter	Result	Wet wt. Units	Reporting Limit	
Acetone	2400	ug/kg	4000	J
Benzene	ND	ug/kg	2000	
Bromodichloromethane	ND	ug/kg	2000	
Bromoform	ND	ug/kg	2000	
Bromomethane	ND	ug/kg	4000	
2-Butanone (MEK)	ND	ug/kg	4000	
Carbon disulfide	ND	ug/kg	2000	
Carbon tetrachloride	ND	ug/kg	2000	
Chlorobenzene	ND	ug/kg	2000	
Chloroethane	ND	ug/kg	4000	
Chloroform	ND	ug/kg	2000	
Chloromethane	ND	ug/kg	4000	
Dibromochloromethane	ND	ug/kg	2000	
1,1-Dichloroethane	ND	ug/kg	2000	
1,2-Dichloroethane	ND	ug/kg	2000	
1,1-Dichloroethene	ND	ug/kg	2000	
1,2-Dichloroethene (total)	ND	ug/kg	2000	
1,2-Dichloropropane	ND	ug/kg	2000	
cis-1,3-Dichloropropene	ND	ug/kg	2000	
trans-1,3-Dichloropropene	ND	ug/kg	2000	
Ethylbenzene	ND	ug/kg	2000	
2-Hexanone	ND	ug/kg	4000	
Methylene chloride	520	ug/kg	2000	J
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	4000	
Styrene	ND	ug/kg	2000	
1,1,2,2-Tetrachloroethane	ND	ug/kg	2000	
Tetrachloroethene	ND	ug/kg	2000	
Toluene	27000	ug/kg	2000	
1,1,1-Trichloroethane	ND	ug/kg	2000	
1,1,2-Trichloroethane	ND	ug/kg	2000	
Trichloroethene	ND	ug/kg	2000	
Vinyl acetate	ND	ug/kg	4000	
Vinyl chloride	ND	ug/kg	4000	
Xylenes (total)	ND	ug/kg	2000	
Hexane	ND	ug/kg	--	
n-Butyl alcohol	ND	ug/kg	--	
Isobutanol	ND	ug/kg	80000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz Approved By: Mike Hoffman

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: WCS-6 (8-10 Feet)
Lab ID: 015168-0003-SA
Matrix: SOIL Sampled: 28 MAY 91 Received: 30 MAY 91
Authorized: 30 MAY 91 Prepared: 03 JUN 91 Analyzed: 07 JUN 91

Surrogate	Recovery	
Toluene-d8	94	%
4-Bromofluorobenzene	90	%
1,2-Dichloroethane-d4	86	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Cherie Windholz Approved By: Mike Hoffman

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\% \text{ Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{\left| \text{Measured Concentration DCS1} - \text{Measured Concentration DCS2} \right|}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

Enseco
A Corning Company

QC LOT ASSIGNMENT REPORT
Volatile Organics by GC/MS

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
015168-0001-SA	SOIL	8240-S	29 MAY 91-A	03 JUN 91-A
015168-0002-SA	SOIL	8240-S	29 MAY 91-A	03 JUN 91-A
015168-0003-SA	SOIL	8240-S	29 MAY 91-A	03 JUN 91-A

Enseco
A Corning Company

DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Limits	Precision (RPD) DCS	Limit
Category: 8240-S								
Matrix: SOIL								
QC Lot: 29 MAY 91-A								
Concentration Units: ug/kg								
1,1-Dichloroethene	5000	3780	3460	3620	72	59-172	8.8	22
Trichloroethene	5000	4580	4570	4580	92	62-137	0.2	24
Benzene	5000	4540	4790	4660	93	66-142	5.4	21
Toluene	5000	4960	5140	5050	101	59-139	3.6	21
Chlorobenzene	5000	4680	4920	4800	96	60-133	5.0	21

Calculations are performed before rounding to avoid round-off errors in calculated results.

Enseco
A Corning Company

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Measured	Accuracy(%) SCS	Limits
Category: 8240-S				
Matrix: SOIL				
QC Lot: 29 MAY 91-A QC Run: 03 JUN 91-A				
Concentration Units: ug/kg				
1,2-Dichloroethane-d4	5000	5900	118	70-121
4-Bromofluorobenzene	5000	5460	109	74-121
Toluene-d8	5000	5830	117	81-117

Calculations are performed before rounding to avoid round-off errors in calculated results.

Enseco
A Corning Company

METHOD BLANK REPORT
Volatile Organics by GC/MS

Test: 8240CPM-TCL-S
Matrix: SOIL
QC Lot: 29 MAY 91-A QC Run: 03 JUN 91-A

Analyte	Result	Units	Reporting Limit
Acetone	ND	ug/kg	1000
Benzene	ND	ug/kg	500
Bromodichloromethane	ND	ug/kg	500
Bromoform	ND	ug/kg	500
Bromomethane	ND	ug/kg	1000
2-Butanone (MEK)	ND	ug/kg	1000
Carbon disulfide	ND	ug/kg	500
Carbon tetrachloride	ND	ug/kg	500
Chlorobenzene	ND	ug/kg	500
Chloroethane	ND	ug/kg	1000
Chloroform	ND	ug/kg	500
Chloromethane	ND	ug/kg	1000
Dibromochloromethane	ND	ug/kg	500
1,1-Dichloroethane	ND	ug/kg	500
1,2-Dichloroethane	ND	ug/kg	500
1,1-Dichloroethene	ND	ug/kg	500
1,2-Dichloroethene (total)	ND	ug/kg	500
1,2-Dichloropropane	ND	ug/kg	500
cis-1,3-Dichloropropene	ND	ug/kg	500
trans-1,3-Dichloropropene	ND	ug/kg	500
Ethylbenzene	ND	ug/kg	500
2-Hexanone	ND	ug/kg	1000
Methylene chloride	ND	ug/kg	500
4-Methyl-2-pentanone (MIBK)	ND	ug/kg	1000
Styrene	ND	ug/kg	500
1,1,2,2-Tetrachloroethane	ND	ug/kg	500
Tetrachloroethene	ND	ug/kg	500
Toluene	ND	ug/kg	500
1,1,1-Trichloroethane	ND	ug/kg	500
1,1,2-Trichloroethane	ND	ug/kg	500
Trichloroethene	ND	ug/kg	500
Vinyl acetate	ND	ug/kg	1000
Vinyl chloride	ND	ug/kg	1000
Xylenes (total)	ND	ug/kg	500
Hexane	ND	ug/kg	--
n-Butyl alcohol	ND	ug/kg	--
Isobutanol	ND	ug/kg	20000

Appendix

CHAIN OF CUSTODY RECORD

WOODWARD-CLYDE CONSULTANTS • 5055 ANTIOCH ROAD • OVERLAND PARK, KANSAS 66203 • 913-432-4242

SAMPLER(S)	PROJECT NAME	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET
CHRIS FITZGERALD	SHELLER-GLOBE, KEOKUK IOWA	28 / 05 / 91	1 of 1

CONTENTS OF SHIPMENT

SAMPLE NUMBER	TYPE OF CONTAINERS: CUBITAINER	8oz BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
	NUMBERS OF CONTAINERS PER SAMPLE NUMBER										
WCS-2 (8-10 Feet)		1					X				Collected 5-28-91
WCS-5 (8-10 feet)		1					X				Collected 5-28-91
WCS-6 (8-10 FEET)		1					X				Collected 5-28-91

PLEASE NOTE: The three SAMPLES LISTED ABOVE ARE TO BE ANALYZED FOR VOA (8240) PLUS METHYL ISOBUTYL KETONE, n-hexane and BUTANOL

DESCRIPTION OF SHIPMENT

1 PIECE(S) CONSISTING OF 1 ICE CHEST(S)

RECEIVING LABORATORY: ENSECO - RMAL

MODE OF SHIPMENT

X COMMERCIAL CARRIER: FEDERAL EXPRESS

__ COURIER

__ SAMPLER CONVEYED

0698250243 (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
Chris Fitzgerald ☒ SEALED ☐ UNSEALED	5-29-91	09:38	FEDERAL EXPRESS ☒ SEALED ☐ UNSEALED	SHIP to LAB
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY: Justin Chappell ☒ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY 5/30/91 0800 A.M.
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY ☐ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY

Rocky Mountain
Analytical Laboratory

Enseco
A CORNING Company

June 14, 1991

Mr. David Dods
Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Dear Mr. Dods:

Enclosed is the report for four samples received at Enseco-Rocky Mountain Analytical Laboratory on May 23 and 25, 1991. Pursuant to instructions from you on May 29, 1991, these samples were analyzed for TOC.

Please call if you have any questions.

Sincerely,

Julie Essey
Program Administrator

Reviewed by:

Sue Dalla
Manager
Program Administration

JE/SD/brm
Enclosures

RMAL #015154

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Enseco
A Corning Company

SAMPLE DESCRIPTION INFORMATION
for
Woodward-Clyde Consultants

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
015154-0001-SA	MW-11 30-32'	SOIL	20 MAY 91		23 MAY 91
015154-0002-SA	WCS-7 1-3'	SOIL	23 MAY 91		25 MAY 91
015154-0003-SA	WCS-9 8-10'	SOIL	24 MAY 91		25 MAY 91
015154-0004-SA	MW-12 35-37'	SOIL	24 MAY 91		25 MAY 91

Enseco
A Corning Company

ANALYTICAL TEST REQUESTS
for
Woodward-Clyde Consultants

Lab ID: 015154	Group Code	Analysis Description	Custom Test?
0001 - 0004	A	Total Organic Carbon (TOC)	N

Enseco
A Corning Company

General Inorganics

Client Name: Woodward-Clyde Consultants
Client ID: MW-11 30-32'
Lab ID: 015154-0001-SA
Matrix: SOIL Sampled: 20 MAY 91 Received: 23 MAY 91
Authorized: 29 MAY 91 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Total Organic Carbon	0.29	%	0.02	9060	NA	03 JUN 91

ND = Not detected
NA = Not applicable

Reported By: Paula Hubble Approved By: Toni Stovall

Enseco
A Corning Company

General Inorganics

Client Name: Woodward-Clyde Consultants
Client ID: WCS-7 1-3'
Lab ID: 015154-0002-SA
Matrix: SOIL Sampled: 23 MAY 91 Received: 25 MAY 91
Authorized: 29 MAY 91 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Total Organic Carbon	7.25	%	0.02	9060	NA	03 JUN 91

ND = Not detected
NA = Not applicable

Reported By: Paula Hubble Approved By: Toni Stovall

Enseco
A Corning Company

General Inorganics

Client Name: Woodward-Clyde Consultants
Client ID: WCS-9 8-10'
Lab ID: 015154-0003-SA
Matrix: SOIL Sampled: 24 MAY 91 Received: 25 MAY 91
Authorized: 29 MAY 91 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Total Organic Carbon	0.06	%	0.02	9060	NA	03 JUN 91

ND = Not detected
NA = Not applicable

Reported By: Paula Hubble Approved By: Toni Stovall

Enseco
A Corning Company

General Inorganics

Client Name: Woodward-Clyde Consultants
Client ID: MW-12 35-37'
Lab ID: 015154-0004-SA
Matrix: SOIL Sampled: 24 MAY 91 Received: 25 MAY 91
Authorized: 29 MAY 91 Prepared: See Below Analyzed: See Below

Parameter	Result	Units	Reporting Limit	Analytical Method	Prepared Date	Analyzed Date
Total Organic Carbon	0.15	%	0.02	9060	NA	03 JUN 91

ND = Not detected
NA = Not applicable

Reported By: Paula Hubble Approved By: Toni Stovall

CHAIN OF CUSTODY RECORD

WOODWARD-CLYDE CONSULTANTS • 5055 ANTIOCH ROAD • OVERLAND PARK, KANSAS 66203 • 913-432-4242

SAMPLER(S)	PROJECT NAME	DATE OF COLLECTION	SHEET
Chris Fitzgerald	Sheller-Globe Keokuk, Iowa	20 May 91 (DAY / MONTH / YEAR)	1 of 1

CONTENTS OF SHIPMENT: Rmal # 15095

SAMPLE NUMBER	TYPE OF CONTAINERS: CUBITAINER	8 oz BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
MW-9 (30-35 feet)		1					X				Please Note: * This sample collected on 5-20-91 ***
MW-10 (5-7 feet)		1					X				* This sample collected on 5-21-91 ***

NUMBERS OF CONTAINERS PER SAMPLE NUMBER

Note: Both of these samples are to be analyzed for VOA (Method 8240) plus Methyl Isobutyl ketone, n-hexane, and butanol. *

DESCRIPTION OF SHIPMENT

1 PIECE(S) CONSISTING OF 1 ICE CHEST(S)

RECEIVING LABORATORY: Enseco - RMAL

MODE OF SHIPMENT

X COMMERCIAL CARRIER: Federal Express

___ COURIER

___ SAMPLER CONVEYED

0698250276 (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
Christopher Fitzgerald [X] SEALED [ ] UNSEALED	5-21-91	18:00	Federal Express [X] SEALED [ ] UNSEALED	Ship to LAB
RELINQUISHED BY [ ] SEALED [ ] UNSEALED	DATE	TIME	RECEIVED BY [ ] SEALED [ ] UNSEALED	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY [ ] SEALED [ ] UNSEALED	DATE	TIME	RECEIVED BY 5/23/91 0800 [ ] SEALED [X] UNSEALED	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY [ ] SEALED [ ] UNSEALED	DATE	TIME	RECEIVED BY [ ] SEALED [ ] UNSEALED	REASON FOR CHANGE OF CUSTODY

CHAIN OF CUSTODY RECORD

WOODWARD-CLYDE CONSULTANTS • 5055 ANTIOCH ROAD • OVERLAND PARK, KANSAS 66203 • 913-432-4242

SAMPLER(S)	PROJECT NAME	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET
CHRIS FITZGERALD	SHELLER-GLOBE KEOKUK IOWA	24 / 05 / 91	1 of 1

CONTENTS OF SHIPMENT

SAMPLE NUMBER	TYPE OF CONTAINERS: CONTAINER	8oz BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
	NUMBERS OF CONTAINERS PER SAMPLE NUMBER										
WCS-8 (8-10ft)		1					X				NOTE: ** Collected 5-23-91
WCS-7 (1-3 Feet)	01	1					X				Collected 5-23-91
MW-9 (15-17ft)		1					X				Collected 5-23-91
WCS-9 (8-10ft)	03	1					X				Collected 5-24-91
MW-12* (35-37ft)	04	1					X				Collected 5-24-91
→ Please call David Dodds at Woodward-Clyde Consultants prior to analyzing this sample. (913) 432-4242											Please Note: The 4 samples listed above are to be analyzed for VOA (8240) plus methyl isobutyl ketone, n-hexane and butanol

DESCRIPTION OF SHIPMENT

1 PIECE(S) CONSISTING OF 1 ICE CHEST(S)

RECEIVING LABORATORY: ENSECO - RMAL

MODE OF SHIPMENT

X COMMERCIAL CARRIER: FEDERAL EXPRESS

__ COURIER

__ SAMPLER CONVEYED

0698250232 (SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
Christopher Fitzgerald ☒ SEALED ☐ UNSEALED	5-24-91	16:00	FEDERAL EXPRESS ☒ SEALED ☐ UNSEALED	SHIP TO LABORATORY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY Joe Moss 5/25/91 0920 ☐ SEALED ☒ UNSEALED	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY ☐ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY

Rocky Mountain
Analytical Laboratory

Enseco
A CORNING Company

June 14, 1991

Mr. David Dods
Woodward-Clyde Consultants
5055 Antioch Road
Overland Park, KS 66203

Dear Mr. Dods:

Enclosed is the report for 12 samples received at Enseco-Rocky Mountain Analytical Laboratory on June 3, 1991.

Included with the report is a quality control summary.

Please call if you have any questions.

Sincerely,

Julie Essey
Program Administrator

Reviewed by:

Sue Dalla
Manager
Program Administration

JE/SD/heg
Enclosures

RMAL #015241

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Rocky Mountain
Analytical Laboratory

Enseco

ANALYTICAL RESULTS

FOR

WOODWARD-CLYDE CONSULTANTS

ENSECO-RMAL NO. 015241

JUNE 14, 1991

Reviewed by:

Julie Essey

Sue Dalla

Enseco Incorporated
4955 Yarrow Street
Arvada, Colorado 80002
303/421-6611 Fax: 303/431-7171

Introduction

This report presents the analytical results as well as supporting information to aid in the evaluation and interpretation of the data and is arranged in the following order:

- Sample Description Information
- Analytical Test Requests
- Analytical Results
- Quality Control Report

"J" values have been reported for the volatiles, semivolatiles and metals analyses. A "J" value indicates an estimated value. For Methods 8240 and 8270 a "J" value is where the mass spectra data indicate the presence of a compound which meets identification criteria; however, the result is less than the reporting limit but greater than the instrument detection limit (IDL).

All analyses at Enseco are performed so that the maximum concentration of sample consistent with the method is analyzed. Dilutions are at times required to avoid saturation of the detector, to achieve linearity for a specific target compound or to reduce matrix interferences. In this event, reporting limits are adjusted proportionately. Surrogate compounds may not be measurable in samples which have been diluted.

Samples 015241-0001, -0002, -0004 through -0008 and -0011 by Method 8240 were diluted due to elevated concentrations of target compounds. The reporting limits were raised proportionately.

Acetone and methylene chloride were observed in the method blanks performed for the GC/MS volatile analysis.

For organic analyses, the concentration of target analytes in the blank must be below the reporting limit for that analyte in order for the blank to be considered acceptable. An exception is made for common laboratory contaminants [methylene chloride, acetone, 2-butanone, toluene, and bis(2-ethylhexyl)phthalate] which may be present in the blank at up to five times the reporting limit and still be considered acceptable. This policy is

consistent with the CLP policy and has been established in recognition of the fact that these compounds are frequently found at low levels in method blanks due to the materials used in the collection, preparation, and analysis of samples for organic parameters.

Sample Description Information

The Sample Description Information lists all of the samples received in this project together with the internal laboratory identification number assigned for each sample. Each project received at Enseco - RMAL is assigned a unique six digit number. Samples within the project are numbered sequentially. The laboratory identification number is a combination of the six digit project code and the sample sequence number.

Also given in the Sample Description Information is the Sample Type (matrix), Date of Sampling (if known) and Date of Receipt at the laboratory.

Analytical Test Requests

The Analytical Test Requests lists the analyses that were performed on each sample. The Custom Test column indicates where tests have been modified to conform to the specific requirements of this project.

Enseco
A Corning Company

ANALYTICAL TEST REQUESTS
for
Woodward-Clyde Consultants

Lab ID: 015241	Group Code	Analysis Description	Custom Test?
0001 - 0012	A	Volatile Organics	Y
		Target Compound List (TCL)	Y
		Screen - Volatile Organics	N

SAMPLE DESCRIPTION INFORMATION
for
Woodward-Clyde Consultants

Lab ID	Client ID	Matrix	Sampled Date	Sampled Time	Received Date
015241-0001-SA	MW-1	AQUEOUS	31 MAY 91		03 JUN 91
015241-0002-SA	MW-2	AQUEOUS	31 MAY 91		03 JUN 91
015241-0003-SA	MW-3	AQUEOUS	31 MAY 91		03 JUN 91
015241-0004-SA	MW-4	AQUEOUS	31 MAY 91		03 JUN 91
015241-0005-SA	MW-6A	AQUEOUS	31 MAY 91		03 JUN 91
015241-0006-SA	MW-6B	AQUEOUS	31 MAY 91		03 JUN 91
015241-0007-SA	MW-9	AQUEOUS	31 MAY 91		03 JUN 91
015241-0008-SA	MW-10	AQUEOUS	31 MAY 91		03 JUN 91
015241-0009-SA	MW-11	AQUEOUS	31 MAY 91		03 JUN 91
015241-0010-SA	MW-12	AQUEOUS	31 MAY 91		03 JUN 91
015241-0011-SA	MW-14	AQUEOUS	31 MAY 91		03 JUN 91
015241-0012-TB	TB-1	AQUEOUS	31 MAY 91		03 JUN 91

Analytical Results

The analytical results for this project are presented in the following data tables. Each data table includes sample identification information, and when available and appropriate, dates sampled, received, authorized, prepared and analyzed. The authorization data is the date when the project was defined by the client such that laboratory work could begin.

Data sheets contain a listing of the parameters measured in each test, the analytical results and the Enseco reporting limit. Reporting limits are adjusted to reflect dilution of the sample, when appropriate. Solid and waste samples are reported on an "as received" basis, i.e. no correction is made for moisture content.

Enseco-RMAL is no longer routinely blank-correcting analytical data. Uncorrected analytical results are reported, along with associated blank results, for all organic and metals analyses. Analytical results and blank results are reported for conventional inorganic parameters as specified in the method. This policy is described in detail in the Enseco Incorporated Quality Assurance Program Plan for Environmental Chemical Monitoring, Revision 3.3, May, 1989.

The results from the Standard Enseco QA/QC Program, which generates data which are independent of matrix effects, is provided subsequently.

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-1
Lab ID: 015241-0001-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 09 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	50000	
Benzene	ND	ug/L	25000	
Bromodichloromethane	ND	ug/L	25000	
Bromoform	ND	ug/L	25000	
Bromomethane	ND	ug/L	50000	
2-Butanone (MEK)	ND	ug/L	50000	
Carbon disulfide	7300	ug/L	25000	J
Carbon tetrachloride	ND	ug/L	25000	
Chlorobenzene	ND	ug/L	25000	
Chloroethane	ND	ug/L	50000	
Chloroform	ND	ug/L	25000	
Chloromethane	ND	ug/L	50000	
Dibromochloromethane	ND	ug/L	25000	
1,1-Dichloroethane	ND	ug/L	25000	
1,2-Dichloroethane	ND	ug/L	25000	
1,1-Dichloroethene	ND	ug/L	25000	
1,2-Dichloroethene (total)	ND	ug/L	25000	
1,2-Dichloropropane	ND	ug/L	25000	
cis-1,3-Dichloropropene	ND	ug/L	25000	
trans-1,3-Dichloropropene	ND	ug/L	25000	
Ethylbenzene	ND	ug/L	25000	
2-Hexanone	ND	ug/L	50000	
Methylene chloride	15000	ug/L	25000	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	50000	
Styrene	ND	ug/L	25000	
1,1,2,2-Tetrachloroethane	ND	ug/L	25000	
Tetrachloroethene	ND	ug/L	25000	
Toluene	470000	ug/L	25000	
1,1,1-Trichloroethane	ND	ug/L	25000	
1,1,2-Trichloroethane	ND	ug/L	25000	
Trichloroethene	ND	ug/L	25000	
Vinyl acetate	ND	ug/L	50000	
Vinyl chloride	ND	ug/L	50000	
Xylenes (total)	ND	ug/L	25000	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	1000000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-1
Lab ID: 015241-0001-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 09 JUN 91

Surrogate	Recovery	
Toluene-d8	104	%
4-Bromofluorobenzene	100	%
1,2-Dichloroethane-d4	88	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-2
Lab ID: 015241-0002-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 09 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	50000	
Benzene	ND	ug/L	25000	
Bromodichloromethane	ND	ug/L	25000	
Bromoform	ND	ug/L	25000	
Bromomethane	ND	ug/L	50000	
2-Butanone (MEK)	ND	ug/L	50000	
Carbon disulfide	ND	ug/L	25000	
Carbon tetrachloride	ND	ug/L	25000	
Chlorobenzene	ND	ug/L	25000	
Chloroethane	ND	ug/L	50000	
Chloroform	ND	ug/L	25000	
Chloromethane	ND	ug/L	50000	
Dibromochloromethane	ND	ug/L	25000	
1,1-Dichloroethane	ND	ug/L	25000	
1,2-Dichloroethane	ND	ug/L	25000	
1,1-Dichloroethene	ND	ug/L	25000	
1,2-Dichloroethene (total)	ND	ug/L	25000	
1,2-Dichloropropane	ND	ug/L	25000	
cis-1,3-Dichloropropene	ND	ug/L	25000	
trans-1,3-Dichloropropene	ND	ug/L	25000	
Ethylbenzene	ND	ug/L	25000	
2-Hexanone	ND	ug/L	50000	
Methylene chloride	20000	ug/L	25000	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	50000	
Styrene	ND	ug/L	25000	
1,1,2,2-Tetrachloroethane	ND	ug/L	25000	
Tetrachloroethene	ND	ug/L	25000	
Toluene	450000	ug/L	25000	
1,1,1-Trichloroethane	ND	ug/L	25000	
1,1,2-Trichloroethane	ND	ug/L	25000	
Trichloroethene	ND	ug/L	25000	
Vinyl acetate	ND	ug/L	50000	
Vinyl chloride	ND	ug/L	50000	
Xylenes (total)	ND	ug/L	25000	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	1000000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-2
Lab ID: 015241-0002-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 09 JUN 91

Surrogate	Recovery	
Toluene-d8	103	%
4-Bromofluorobenzene	101	%
1,2-Dichloroethane-d4	86	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-3
Lab ID: 015241-0003-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	36	ug/L	10	
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloroethene (total)	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	1.1	ug/L	5.0	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	39	ug/L	5.0	
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-3
Lab ID: 015241-0003-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	104	%
4-Bromofluorobenzene	102	%
1,2-Dichloroethane-d4	90	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-4
Lab ID: 015241-0004-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 07 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	200	
Benzene	ND	ug/L	100	
Bromodichloromethane	ND	ug/L	100	
Bromoform	ND	ug/L	100	
Bromomethane	ND	ug/L	200	
2-Butanone (MEK)	ND	ug/L	200	
Carbon disulfide	ND	ug/L	100	
Carbon tetrachloride	ND	ug/L	100	
Chlorobenzene	ND	ug/L	100	
Chloroethane	ND	ug/L	200	
Chloroform	ND	ug/L	100	
Chloromethane	ND	ug/L	200	
Dibromochloromethane	ND	ug/L	100	
1,1-Dichloroethane	ND	ug/L	100	
1,2-Dichloroethane	ND	ug/L	100	
1,1-Dichloroethene	ND	ug/L	100	
1,2-Dichloroethene (total)	ND	ug/L	100	
1,2-Dichloropropane	ND	ug/L	100	
cis-1,3-Dichloropropene	ND	ug/L	100	
trans-1,3-Dichloropropene	ND	ug/L	100	
Ethylbenzene	ND	ug/L	100	
2-Hexanone	ND	ug/L	200	
Methylene chloride	81	ug/L	100	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	200	
Styrene	ND	ug/L	100	
1,1,2,2-Tetrachloroethane	ND	ug/L	100	
Tetrachloroethene	ND	ug/L	100	
Toluene	1100	ug/L	100	
1,1,1-Trichloroethane	ND	ug/L	100	
1,1,2-Trichloroethane	ND	ug/L	100	
Trichloroethene	ND	ug/L	100	
Vinyl acetate	ND	ug/L	200	
Vinyl chloride	ND	ug/L	200	
Xylenes (total)	ND	ug/L	100	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	4000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-4
Lab ID: 015241-0004-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 07 JUN 91

Surrogate	Recovery	
Toluene-d8	110	%
4-Bromofluorobenzene	102	%
1,2-Dichloroethane-d4	92	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-6A
Lab ID: 015241-0005-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 07 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	3600	ug/L	3300	
Benzene	ND	ug/L	1600	
Bromodichloromethane	ND	ug/L	1600	
Bromoform	ND	ug/L	1600	
Bromomethane	ND	ug/L	3300	
2-Butanone (MEK)	ND	ug/L	3300	
Carbon disulfide	ND	ug/L	1600	
Carbon tetrachloride	ND	ug/L	1600	
Chlorobenzene	ND	ug/L	1600	
Chloroethane	ND	ug/L	3300	
Chloroform	ND	ug/L	1600	
Chloromethane	ND	ug/L	3300	
Dibromochloromethane	ND	ug/L	1600	
1,1-Dichloroethane	ND	ug/L	1600	
1,2-Dichloroethane	ND	ug/L	1600	
1,1-Dichloroethene	ND	ug/L	1600	
1,2-Dichloroethene (total)	ND	ug/L	1600	
1,2-Dichloropropane	ND	ug/L	1600	
cis-1,3-Dichloropropene	ND	ug/L	1600	
trans-1,3-Dichloropropene	ND	ug/L	1600	
Ethylbenzene	19000	ug/L	1600	
2-Hexanone	ND	ug/L	3300	
Methylene chloride	400	ug/L	1600	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	3300	
Styrene	ND	ug/L	1600	
1,1,2,2-Tetrachloroethane	ND	ug/L	1600	
Tetrachloroethene	ND	ug/L	1600	
Toluene	25000	ug/L	1600	
1,1,1-Trichloroethane	ND	ug/L	1600	
1,1,2-Trichloroethane	ND	ug/L	1600	
Trichloroethene	ND	ug/L	1600	
Vinyl acetate	ND	ug/L	3300	
Vinyl chloride	ND	ug/L	3300	
Xylenes (total)	56000	ug/L	1600	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	66000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-6A
Lab ID: 015241-0005-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 07 JUN 91

Surrogate	Recovery	
Toluene-d8	107	%
4-Bromofluorobenzene	110	%
1,2-Dichloroethane-d4	89	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-6B
Lab ID: 015241-0006-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	50	
Benzene	ND	ug/L	25	
Bromodichloromethane	ND	ug/L	25	
Bromoform	ND	ug/L	25	
Bromomethane	ND	ug/L	50	
2-Butanone (MEK)	ND	ug/L	50	
Carbon disulfide	ND	ug/L	25	
Carbon tetrachloride	ND	ug/L	25	
Chlorobenzene	ND	ug/L	25	
Chloroethane	ND	ug/L	50	
Chloroform	ND	ug/L	25	
Chloromethane	ND	ug/L	50	
Dibromochloromethane	ND	ug/L	25	
1,1-Dichloroethane	ND	ug/L	25	
1,2-Dichloroethane	ND	ug/L	25	
1,1-Dichloroethene	ND	ug/L	25	
1,2-Dichloroethene (total)	18	ug/L	25	J
1,2-Dichloropropane	ND	ug/L	25	
cis-1,3-Dichloropropene	ND	ug/L	25	
trans-1,3-Dichloropropene	ND	ug/L	25	
Ethylbenzene	170	ug/L	25	
2-Hexanone	ND	ug/L	50	
Methylene chloride	5.8	ug/L	25	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	50	
Styrene	ND	ug/L	25	
1,1,2,2-Tetrachloroethane	ND	ug/L	25	
Tetrachloroethene	ND	ug/L	25	
Toluene	680	ug/L	25	
1,1,1-Trichloroethane	ND	ug/L	25	
1,1,2-Trichloroethane	ND	ug/L	25	
Trichloroethene	11	ug/L	25	J
Vinyl acetate	ND	ug/L	50	
Vinyl chloride	ND	ug/L	50	
Xylenes (total)	460	ug/L	25	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	1000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-6B
Lab ID: 015241-0006-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	106	%
4-Bromofluorobenzene	104	%
1,2-Dichloroethane-d4	88	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-9
Lab ID: 015241-0007-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	50	
Benzene	ND	ug/L	25	
Bromodichloromethane	ND	ug/L	25	
Bromoform	ND	ug/L	25	
Bromomethane	ND	ug/L	50	
2-Butanone (MEK)	ND	ug/L	50	
Carbon disulfide	ND	ug/L	25	
Carbon tetrachloride	ND	ug/L	25	
Chlorobenzene	ND	ug/L	25	
Chloroethane	ND	ug/L	50	
Chloroform	ND	ug/L	25	
Chloromethane	ND	ug/L	50	
Dibromochloromethane	ND	ug/L	25	
1,1-Dichloroethane	ND	ug/L	25	
1,2-Dichloroethane	ND	ug/L	25	
1,1-Dichloroethene	ND	ug/L	25	
1,2-Dichloroethene (total)	ND	ug/L	25	
1,2-Dichloropropane	ND	ug/L	25	
cis-1,3-Dichloropropene	ND	ug/L	25	
trans-1,3-Dichloropropene	ND	ug/L	25	
Ethylbenzene	ND	ug/L	25	
2-Hexanone	ND	ug/L	50	
Methylene chloride	ND	ug/L	25	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	50	
Styrene	ND	ug/L	25	
1,1,2,2-Tetrachloroethane	ND	ug/L	25	
Tetrachloroethene	ND	ug/L	25	
Toluene	460	ug/L	25	
1,1,1-Trichloroethane	ND	ug/L	25	
1,1,2-Trichloroethane	ND	ug/L	25	
Trichloroethene	ND	ug/L	25	
Vinyl acetate	ND	ug/L	50	
Vinyl chloride	ND	ug/L	50	
Xylenes (total)	9.8	ug/L	25	J
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	1000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-9
Lab ID: 015241-0007-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	108	%
4-Bromofluorobenzene	101	%
1,2-Dichloroethane-d4	87	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-10
Lab ID: 015241-0008-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	2000	
Benzene	ND	ug/L	1000	
Bromodichloromethane	ND	ug/L	1000	
Bromoform	ND	ug/L	1000	
Bromomethane	ND	ug/L	2000	
2-Butanone (MEK)	ND	ug/L	2000	
Carbon disulfide	ND	ug/L	1000	
Carbon tetrachloride	ND	ug/L	1000	
Chlorobenzene	ND	ug/L	1000	
Chloroethane	ND	ug/L	2000	
Chloroform	ND	ug/L	1000	
Chloromethane	670	ug/L	2000	J
Dibromochloromethane	ND	ug/L	1000	
1,1-Dichloroethane	ND	ug/L	1000	
1,2-Dichloroethane	ND	ug/L	1000	
1,1-Dichloroethene	660	ug/L	1000	J
1,2-Dichloroethene (total)	290	ug/L	1000	J
1,2-Dichloropropane	ND	ug/L	1000	
cis-1,3-Dichloropropene	ND	ug/L	1000	
trans-1,3-Dichloropropene	ND	ug/L	1000	
Ethylbenzene	370	ug/L	1000	J
2-Hexanone	ND	ug/L	2000	
Methylene chloride	23000	ug/L	1000	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	2000	
Styrene	ND	ug/L	1000	
1,1,2,2-Tetrachloroethane	ND	ug/L	1000	
Tetrachloroethene	840	ug/L	1000	J
Toluene	9000	ug/L	1000	
1,1,1-Trichloroethane	1400	ug/L	1000	
1,1,2-Trichloroethane	ND	ug/L	1000	
Trichloroethene	1900	ug/L	1000	
Vinyl acetate	ND	ug/L	2000	
Vinyl chloride	ND	ug/L	2000	
Xylenes (total)	1100	ug/L	1000	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	40000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-10
Lab ID: 015241-0008-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	104	%
4-Bromofluorobenzene	99	%
1,2-Dichloroethane-d4	89	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-11
Lab ID: 015241-0009-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	12	ug/L	10	
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloroethene (total)	4.3	ug/L	5.0	J
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	1.0	ug/L	5.0	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	1.6	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	2.2	ug/L	5.0	J
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-11
Lab ID: 015241-0009-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	91	%
4-Bromofluorobenzene	96	%
1,2-Dichloroethane-d4	90	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-12
Lab ID: 015241-0010-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	7.4	ug/L	10	J
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloroethene (total)	1.8	ug/L	5.0	J
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	1.4	ug/L	5.0	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	5.7	ug/L	5.0	
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	3.1	ug/L	10	J
Xylenes (total)	ND	ug/L	5.0	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-12
Lab ID: 015241-0010-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	100	%
4-Bromofluorobenzene	97	%
1,2-Dichloroethane-d4	90	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-14
Lab ID: 015241-0011-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	50	
Benzene	ND	ug/L	25	
Bromodichloromethane	ND	ug/L	25	
Bromoform	ND	ug/L	25	
Bromomethane	ND	ug/L	50	
2-Butanone (MEK)	ND	ug/L	50	
Carbon disulfide	ND	ug/L	25	
Carbon tetrachloride	ND	ug/L	25	
Chlorobenzene	ND	ug/L	25	
Chloroethane	ND	ug/L	50	
Chloroform	ND	ug/L	25	
Chloromethane	ND	ug/L	50	
Dibromochloromethane	ND	ug/L	25	
1,1-Dichloroethane	ND	ug/L	25	
1,2-Dichloroethane	ND	ug/L	25	
1,1-Dichloroethene	ND	ug/L	25	
1,2-Dichloroethene (total)	ND	ug/L	25	
1,2-Dichloropropane	ND	ug/L	25	
cis-1,3-Dichloropropene	ND	ug/L	25	
trans-1,3-Dichloropropene	ND	ug/L	25	
Ethylbenzene	ND	ug/L	25	
2-Hexanone	ND	ug/L	50	
Methylene chloride	ND	ug/L	25	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	50	
Styrene	ND	ug/L	25	
1,1,2,2-Tetrachloroethane	ND	ug/L	25	
Tetrachloroethene	ND	ug/L	25	
Toluene	410	ug/L	25	
1,1,1-Trichloroethane	ND	ug/L	25	
1,1,2-Trichloroethane	ND	ug/L	25	
Trichloroethene	ND	ug/L	25	
Vinyl acetate	ND	ug/L	50	
Vinyl chloride	ND	ug/L	50	
Xylenes (total)	7.3	ug/L	25	J
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	1000	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: MW-14
Lab ID: 015241-0011-SA
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	96	%
4-Bromofluorobenzene	93	%
1,2-Dichloroethane-d4	92	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: TB-1
Lab ID: 015241-0012-TB
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Parameter	Result	Units	Reporting Limit	
Acetone	ND	ug/L	10	
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	1.1	ug/L	5.0	J
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloroethene (total)	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	ND	ug/L	5.0	
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	2.5	ug/L	5.0	J
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	200	

(continued on following page)

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Enseco
A Corning Company

Volatile Organics
Target Compound List (TCL)
Method 8240

Client Name: Woodward-Clyde Consultants
Client ID: TB-1
Lab ID: 015241-0012-TB
Matrix: AQUEOUS Sampled: 31 MAY 91 Received: 03 JUN 91
Authorized: 03 JUN 91 Prepared: 04 JUN 91 Analyzed: 10 JUN 91

Surrogate	Recovery	
Toluene-d8	95	%
4-Bromofluorobenzene	98	%
1,2-Dichloroethane-d4	89	%

Note J : Result is detected below the reporting limit or is an estimated concentration.

ND = Not detected
NA = Not applicable

Reported By: Robert Broderick Approved By: Mark Dymerski

Quality Control Results

The Enseco laboratories operate under a vigorous QA/QC program designed to ensure the generation of scientifically valid, legally defensible data by monitoring every aspect of laboratory operations. Routine QA/QC procedures include the use of approved methodologies, independent verification of analytical standards, use of duplicate Laboratory Control Samples to assess the precision and accuracy of the methodology on a routine basis, and a rigorous system of data review.

In addition, the Enseco laboratories maintain a comprehensive set of certifications from both state and federal governmental agencies which require frequent analyses of blind audit samples. Enseco - Rocky Mountain Analytical Laboratory is certified by the EPA under the EPA/CLP program for both Organic and Inorganic analyses, under the USATHAMA (U.S. Army) program, by the Army Corps of Engineers, and the states of Colorado, New Jersey, New York, Utah, and Florida, among others.

The standard laboratory QC package is designed to:

1) establish a strong, cost-effective QC program that ensures the generation of scientifically valid, legally defensible data

2) assess the laboratory's performance of the analytical method using control limits generated with a well-defined matrix

3) establish clear-cut guidelines for acceptability of analytical data so that QC decisions can be made immediately at the bench, and

4) provide a standard set of reportables which assures the client of the quality of his data.

The Enseco QC program is based upon monitoring the precision and accuracy of an analytical method by analyzing a set of Duplicate Control Samples (DCS) at frequent, well-defined intervals. Each DCS is a well-characterized matrix which is spiked with target compounds at 5-100 times the reporting limit, depending upon the methodology being monitored. The purpose of the DCS is not to duplicate the sample matrix, but rather to provide an interference-free, homogeneous matrix from which to gather data to establish control limits. These limits are used to determine whether data generated by the laboratory on any given day is in control.

Control limits for accuracy (percent recovery) are based on the average, historical percent recovery +/- 3 standard deviation units. Control limits for precision (relative percent difference) range from 0 (identical duplicate DCS results) to the average, historical relative percent difference + 3 standard deviation units. These control limits are fairly narrow based on the consistency of the matrix being monitored and are updated on a quarterly basis.

For each batch of samples analyzed, an additional control measure is taken in the form of a Single Control Sample (SCS). The SCS consists of a control matrix that is spiked with either representative target compounds or surrogate compounds appropriate to the method being used. An SCS is prepared for each sample lot for which the DCS pair are not analyzed.

Accuracy for DCS and SCS is measured by Percent Recovery.

$$\% \text{ Recovery} = \frac{\text{Measured Concentration}}{\text{Actual Concentration}} \times 100$$

Precision for DCS is measured by Relative Percent Difference (RPD).

$$\text{RPD} = \frac{\left| \text{Measured Concentration DCS1} - \text{Measured Concentration DCS2} \right|}{(\text{Measured Concentration DCS1} + \text{Measured Concentration DCS2})/2} \times 100$$

All samples analyzed concurrently by the same test are assigned the same QC lot number. Projects which contain numerous samples, analyzed over several days, may have multiple QC lot numbers associated with each test. The QC information which follows includes a listing of the QC lot numbers associated with each of the samples reported, DCS and SCS (where applicable) recoveries from the QC lots associated with the samples, and control limits for these lots. The QC data is reported by test code, in the order that the tests are reported in the analytical results section of this report.

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QC LOT ASSIGNMENT REPORT
Volatile Organics by GC/MS

Laboratory Sample Number	QC Matrix	QC Category	QC Lot Number (DCS)	QC Run Number (SCS/BLANK)
015241-0001-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0002-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0003-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0004-SA	AQUEOUS	624-A	03 JUN 91-F	06 JUN 91-F
015241-0005-SA	AQUEOUS	624-A	03 JUN 91-F	06 JUN 91-F
015241-0006-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0007-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0008-SA	AQUEOUS	624-A	03 JUN 91-F	10 JUN 91-F
015241-0009-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0010-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0011-SA	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F
015241-0012-TB	AQUEOUS	624-A	03 JUN 91-F	09 JUN 91-F

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DUPLICATE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Measured DCS1	Measured DCS2	AVG	Accuracy Average(%) DCS	Accuracy Limits	Precision (RPD) DCS	Precision Limit
Category: 624-A Matrix: AQUEOUS QC Lot: 03 JUN 91-F Concentration Units: ug/L								
1,1-Dichloroethene	50	53.6	51.1	52.4	105	61-145	4.8	14
Trichloroethene	50	46.1	47.0	46.6	93	71-120	1.9	14
Benzene	50	48.0	47.9	48.0	96	76-127	0.2	11
Toluene	50	50.1	50.8	50.4	101	76-125	1.4	13
Chlorobenzene	50	47.7	49.7	48.7	97	75-130	4.1	13

Calculations are performed before rounding to avoid round-off errors in calculated results.

Enseco
A Corning Company

SINGLE CONTROL SAMPLE REPORT
Volatile Organics by GC/MS

Analyte	Concentration Spiked	Concentration Measured	Accuracy(%) SCS	Accuracy(%) Limits
Category: 624-A Matrix: AQUEOUS QC Lot: 03 JUN 91-F QC Run: 09 JUN 91-F Concentration Units: ug/L				
1,2-Dichloroethane-d4	50.0	46.6	93	76-114
4-Bromofluorobenzene	50.0	52.5	105	86-115
Toluene-d8	50.0	52.4	105	88-110
Category: 624-A Matrix: AQUEOUS QC Lot: 03 JUN 91-F QC Run: 06 JUN 91-F Concentration Units: ug/L				
1,2-Dichloroethane-d4	50.0	45.3	91	76-114
4-Bromofluorobenzene	50.0	53.2	106	86-115
Toluene-d8	50.0	55.2	110	88-110
Category: 624-A Matrix: AQUEOUS QC Lot: 03 JUN 91-F QC Run: 10 JUN 91-F Concentration Units: ug/L				
1,2-Dichloroethane-d4	50.0	45.1	90	76-114
4-Bromofluorobenzene	50.0	49.2	98	86-115
Toluene-d8	50.0	49.1	98	88-110

Calculations are performed before rounding to avoid round-off errors in calculated results.

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A Corning Company

METHOD BLANK REPORT
Volatile Organics by GC/MS

Test: 8240CP-TCL-AP
Matrix: AQUEOUS
QC Lot: 03 JUN 91-F QC Run: 09 JUN 91-F

Analyte	Result	Units	Reporting Limit
Acetone	ND	ug/L	10
Benzene	ND	ug/L	5.0
Bromodichloromethane	ND	ug/L	5.0
Bromoform	ND	ug/L	5.0
Bromomethane	ND	ug/L	10
2-Butanone (MEK)	ND	ug/L	10
Carbon disulfide	ND	ug/L	5.0
Carbon tetrachloride	ND	ug/L	5.0
Chlorobenzene	ND	ug/L	5.0
Chloroethane	ND	ug/L	10
Chloroform	ND	ug/L	5.0
Chloromethane	ND	ug/L	10
Dibromochloromethane	ND	ug/L	5.0
1,1-Dichloroethane	ND	ug/L	5.0
1,2-Dichloroethane	ND	ug/L	5.0
1,1-Dichloroethene	ND	ug/L	5.0
1,2-Dichloroethene (total)	ND	ug/L	5.0
1,2-Dichloropropane	ND	ug/L	5.0
cis-1,3-Dichloropropene	ND	ug/L	5.0
trans-1,3-Dichloropropene	ND	ug/L	5.0
Ethylbenzene	ND	ug/L	5.0
2-Hexanone	ND	ug/L	10
Methylene chloride	ND	ug/L	5.0
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10
Styrene	ND	ug/L	5.0
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0
Tetrachloroethene	ND	ug/L	5.0
Toluene	ND	ug/L	5.0
1,1,1-Trichloroethane	ND	ug/L	5.0
1,1,2-Trichloroethane	ND	ug/L	5.0
Trichloroethene	ND	ug/L	5.0
Vinyl acetate	ND	ug/L	10
Vinyl chloride	ND	ug/L	10
Xylenes (total)	ND	ug/L	5.0
Hexane	ND	ug/L	--
n-Butyl alcohol	ND	ug/L	--
Isobutanol	ND	ug/L	200

METHOD BLANK REPORT
Volatile Organics by GC/MS (cont.)

Test: 8240CP-TCL-AP
Matrix: AQUEOUS
QC Lot: 03 JUN 91-F QC Run: 06 JUN 91-F

Analyte	Result	Units	Reporting Limit	
Acetone	ND	ug/L	10	
Benzene	ND	ug/L	5.0	
Bromodichloromethane	ND	ug/L	5.0	
Bromoform	ND	ug/L	5.0	
Bromomethane	ND	ug/L	10	
2-Butanone (MEK)	ND	ug/L	10	
Carbon disulfide	ND	ug/L	5.0	
Carbon tetrachloride	ND	ug/L	5.0	
Chlorobenzene	ND	ug/L	5.0	
Chloroethane	ND	ug/L	10	
Chloroform	ND	ug/L	5.0	
Chloromethane	ND	ug/L	10	
Dibromochloromethane	ND	ug/L	5.0	
1,1-Dichloroethane	ND	ug/L	5.0	
1,2-Dichloroethane	ND	ug/L	5.0	
1,1-Dichloroethene	ND	ug/L	5.0	
1,2-Dichloroethene (total)	ND	ug/L	5.0	
1,2-Dichloropropane	ND	ug/L	5.0	
cis-1,3-Dichloropropene	ND	ug/L	5.0	
trans-1,3-Dichloropropene	ND	ug/L	5.0	
Ethylbenzene	ND	ug/L	5.0	
2-Hexanone	ND	ug/L	10	
Methylene chloride	1.5	ug/L	5.0	J
4-Methyl-2-pentanone (MIBK)	ND	ug/L	10	
Styrene	ND	ug/L	5.0	
1,1,2,2-Tetrachloroethane	ND	ug/L	5.0	
Tetrachloroethene	ND	ug/L	5.0	
Toluene	ND	ug/L	5.0	
1,1,1-Trichloroethane	ND	ug/L	5.0	
1,1,2-Trichloroethane	ND	ug/L	5.0	
Trichloroethene	ND	ug/L	5.0	
Vinyl acetate	ND	ug/L	10	
Vinyl chloride	ND	ug/L	10	
Xylenes (total)	ND	ug/L	5.0	
Hexane	ND	ug/L	--	
n-Butyl alcohol	ND	ug/L	--	
Isobutanol	ND	ug/L	200	

Appendix

CHAIN OF CUSTODY RECORD

WOODWARD-CLYDE CONSULTANTS • 5055 ANTIOCH ROAD • OVERLAND PARK, KANSAS 66203 • 913-432-4242

SAMPLER(S)	PROJECT NAME	DATE OF COLLECTION (DAY / MONTH / YEAR)	SHEET
CHRIS FITZGERALD	SHELLER-GLOBE KEOKUK, IOWA	31 / 05 / 91	1 of 1

CONTENTS OF SHIPMENT (3 VIALS PER SET)

SAMPLE NUMBER	TYPE OF CONTAINERS: CUBITAINER	BOTTLE	BOTTLE	BOTTLE	VOA SET (2 VIALS EA)	SAMPLED MEDIA: water	soil	sediment	dust	other	RECEIVING LABORATORY REMARKS/OTHER INFORMATION (condition of samples upon receipt, other sample numbers, etc.)
	NUMBERS OF CONTAINERS PER SAMPLE NUMBER										
MW-1				1524A-1	1	X					
MW-2				2	1	X					PLEASE NOTE:
MW-3				3	1	X					
MW-4				4	1	X					THE 12 SAMPLES
MW-6A				5	1	X					LISTED ON THIS
MW-6B				6	1	X					CHAIN-OF-CUSTODY
MW-9				7	1	X					FORM ARE TO
MW-10				8	1	X					BE ANALYZED FOR
MW-11				9	1	X					VOA METHOD
MW-12				10	1	X					8240 plus
MW-14				11	1	X					METHYL ISOBUTYL
TB-1				12	1	X					KETONE, N-HEXANE,
(1 VIAL ONLY)					1	X					AND BUTANOL

DESCRIPTION OF SHIPMENT

1 PIECE(S) CONSISTING OF 1 ICE CHEST(S)

RECEIVING LABORATORY: ENSECO - RMAL

MODE OF SHIPMENT

X COMMERCIAL CARRIER: FEDERAL EXPRESS

__ COURIER

__ SAMPLER CONVEYED

(SHIPPING DOCUMENT NUMBER)

PERSONNEL CUSTODY RECORD

RELINQUISHED BY (SAMPLER)	DATE	TIME	RECEIVED BY	REASON FOR CHANGE OF CUSTODY
Christopher Fitzgerald ☒ SEALED ☐ UNSEALED	6-1-91	12:00	FEDERAL EXPRESS ☒ SEALED ☐ UNSEALED	SHIP TO LABORATORY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY Rmal BMagor 3 June 91 0800 ☐ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY
RELINQUISHED BY ☐ SEALED ☐ UNSEALED	DATE	TIME	RECEIVED BY ☐ SEALED ☐ UNSEALED	REASON FOR CHANGE OF CUSTODY